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ABSTRACT

This extrapolation paper is intended: (1) to present a model of a pretechnical curriculum that has as its focus the self-empowerment of the individual and (2) to describe how the curriculum could be implemented in the schools. The first part of the paper discusses the need for a pretechnical curriculum in terms of a model for self-empowerment. Addressed in the next two chapters are employer and employee needs in the labor market of the future and criteria for curricular decisions. Next, the concepts of personal and occupational transitions are examined, and a model for handling transitions is provided. Covered in the next chapter, the largest section in the report, are the need for developing problem-solving skills, a model for solving problems, strategies for developing higher order problem-solving skills, skills for use in developing logical and critical thinking skills, and the role of interpersonal skills in the group problem-solving processes. The final chapter is an implementation guide that presents strategies for fusing generalizable, transition, and problem-solving skills in pretechnical and technical education courses to prepare students for entry-level jobs, training programs, or retraining programs. (MN)

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Implementing Vocational Education in the Schools: An Alternative Curriculum

Illinois State Board of Education

Department of Adult, Vocational and Technical Education

ED250477

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Executive Summary

More than a decade ago Alfred Toffler (1970) predicted that most people would be ill prepared to cope with the changes that would occur in their life times. Today, few people would disagree with Toffler's predictions. Rapid technological advances have not only transformed present worklife, they have drastically altered the future, especially the future of work.

Now workers are continually confronted with change. Self help is repacing corporate or institutional help. Traditional views of labor and management are rapidly changing as the economy moves from an industrial to an informational base. The composition of the work force is changing. New equipment and techniques are making jobs obsolete. More workers are experiencing the reality of changing jobs or entering retraining programs. The prospect of multiple job changes during an occupational life span is becoming certain. Tomorrow's workers will be confronted with even more changes.

One product of this technological explosion has been the reemphasis on the human dimension of the work place. Human resources are increasingly recognized as the least understood and most under utilized element in the work place. Some experts have suggested that the future of the marketplace depends on the ability of business and industry to maximize the personal power of the members of the work force. An increase in personal power is dependent on individuals' abilities to learn new ways to adapt with impending change. Vocational education has always been influenced by technological innovations that influence the requirements of occupations and work environments. Typically a central feature of vocational education programs is specialized job skill training which assumes that vocational training programs are most effective when they emphasize highly specialized skills which are tied to specific needs of employers, particular pieces of equipment, or production processes. Programs of this type have enjoyed a long and strong tradition among vocational educators, and in the

past have often been very successful.

Preparing students to work and live in a technological world creates new responsibilities for vocational educators. In addition to satisfying their traditional functions, vocational educators have to consider two important and related tasks. The first task involves the identification of a body of knowledge and skills that will allow individuals the option of starting at entry level in available occupations or of undertaking more specific education and training. The second task concerns the integration of that body of knowledge and skills into a curriculum which may be implemented in the schools. This extrapolation paper is a response to both of these tasks.

The purpose of this paper is to present a model of a pretechnical curriculum which has as its focus the self-empowerment of the individual and to describe how this curriculum could be implemented in the schools. "Self empowerment" refers to an individual's ability to understand and to deal effectively with career and life options and events as they occur. People's ability to understand and deal with available options and actual events is related to their mastery of three categories of interrelated skills and knowledge which represent the core of our proposed pretechnical curriculum. The three categories are: Generalizable Skills, Transition Skills, and Problem Solving Skills.

Need for a Pretechnical Curriculum

Introduction: A Model for Self-Empowerment

Basic skills are a reflection of Americans' work activities and values. For a long time, it has been relatively easy to revise basic skills as technology and society changed. But now changes are occurring so rapidly that predicting lifelong basic skill needs has become very difficult. In fact, change itself has become the only predictable certainty of the future. Already, the ability to deal with change is critical for many Americans. They are now confronting changes in their jobs, changes in their schooling, changes in their personal lives, and changes in the world around them. Contemporary education must provide opportunities for students to learn to adapt with these changes, and the skills to do so must be considered basic skills. This paper describes a model for preparing students to adapt and cope with change.

Change has always been central to American life. More than a century ago, de Tocqueville remarked that "the American has no time to tie himself to anything, he grows accustomed only to change and he ends by regarding it as a natural state of man" (Pierson, 1938). This social commentary about nineteenth century America seems remarkably apt as our nation approaches the 21st century. Contemporary theorists (Schlossberg, 1984, 1981; Moos & Tsu, 1979; Schneider, 1984; Levinson, 1978; Bridges, 1980; Gould, 1978) have noted that American adults are encountering an increasing number of changes during their lifespans which call for new patterns of behavior or for revisions in their perceptions of self and environment.

Even though our predecessors always accepted and adapted to change, they usually had relatively stable lifestyles. Contemporary Americans, however, are living in the midst of a technological revolution for which the rate of change is accelerating. They will have to be even more flexible, more

versatile, and more adaptable in planning and actualizing their respective careers and lives (Pratzner, 1978; Naisbitt, 1982). They will have to learn how to learn throughout the rest of their lives. Ample support for this assertion is available.

> From Action for Excellence (1983): "We don't believe a high school graduate in 1985 will retire 35 years from now from the same job for which he was hired--during that period he will need to be trained and retrained many times."
>
> A Nation at Risk (1983) stated that, "In our view, formal schooling in youth is the essential formulation for learning throughout one's life. But without life-long learning one's skills will become rapidly dated."
>
> The Paideia Proposal (1982) asserts that, "Learning never reaches a terminal point. As long as one remains alive and healthy, learning can go on and should."

Educational systems will be called upon to play a central role in educating students who can adaptively respond to the changes that the future holds. Parents will expect schools to provide the skills and strategies that their children will need to survive and prosper with ever increasing social and technological change as they enter the world of work. In the monograph Adaption to Work (Ashley, 1980), from the National Center for Research in Vocational Education, it was noted that an inability of many workers in the American labor force was that of adapting to the changes, demands, and responsibilities of work. Business and industry will look to the schools to produce workers who possess and manage skills which contribute to achievement of employers' goals. Education has no alternative but to respond to this

emerging imparative because society will surely hold public schools accountable for accomplishing this important task.

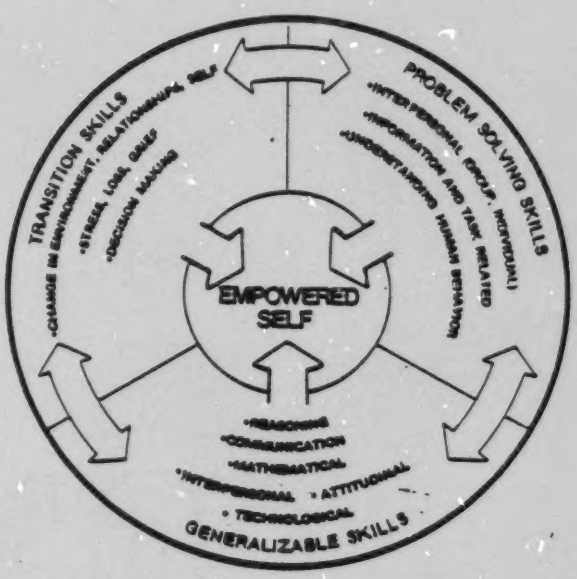
How should the educational community respond to these clear, urgent, and pressing demands? Alternative solutions have been proposed from a variety of sources (Adler, 1982; Botkin, Dimancescu & Stata, 1982; Boyer, 1983; DeBevoise, 1982; Goodlad, 1982; Gisi & Forbes, 1982; Naisbitt, 1982; Pratzner, 1978; Ravitch, 1983; Selz, 1980; Timpane, 1982). Based on a review of these and other resources, our own research, interviews and workshops, the authors have identified a comprehensive model for pretechnical curricula for preparing students to adapt with change. The model has two basic assumptions.

ASSUMPTION: The nature of work in the future will be characterized by constant change, which means that most workers will be employed in several different jobs within or across occupational clusters during their lifetimes. Accelerated change represents a significant factor which must be considered by individuals as they prepare for their initial employment.

ASSUMPTION: Individuals' employability options in the future will be shaped by the acquisition and maintenance of specific classes of skills and knowledge. Three classes of such skills and knowledge have been identified: Generalizable Skills, Problem Solving Skills, and Transition Skills.

The figure below displays three classes of skills and knowledge within which insturctional strategies and pretechnical curricula decisions may be developed.

SKILLS FOR ADAPTING WITH CHANGE



DEFINITION: Generalizable Skills and knowledge (hereafter refered to as Generalizable Skills) actively used in work performance, which are transferable across jobs and occupations and which are instrumental to success on the job and in the classroom. Examples include mathematical, reasoning, communication (written and oral), interpersonal, technological, and attitudinal skills.

DEFINITION: Transition Skills and knowledge (hereafter refered to as Transition Skills) are used to manage life transitions, especially occupationally related ones. They include managing changes in the environment, in relationships, and in oneself; managing stress, loss, and grief; and making decisions.

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DEFINITION: Problem Solving Skills and knowledge (hereafter refered to as Problem Solving Skills) are employed in the resolution of problematic situations including interpersonal problems (group and individual), information and task-related problems, and problems related to people's behavior in cooperative groups.

Two classes of skills from the model are discussed in this report, Transitional Skills and Problem Solving Skills. Generalizable Skills have been described in detail in several current sources, one of which is Greenan's Identification of Generalizable Skills in Secondary Vocational Programs (1983). Generalizable Skills, including the 3 R's of reading, writing, and arithmetic, are crucial for adapting with change, but they are no longer a sufficient education for the workers of tomorrow. We have extended essential skills to include Transition Skills and Problem Solving Skills. These skills will help provide tomorrow's worker the opportunity for life-long employability and well-being.

A transition has been described as an event or nonevent resulting in a change in relationships, routines, assumptions, or roles within the setting of self, work, family, school, health, or finances (Schlossberg, 1984). Adolescents face many transitions: becoming educated, choosing a career, finding first jobs, seeking individual identity. Passage from youth to young adulthood often involves decisions to marry, to drop out of school, to leave parents, and to have children. Throughout their life-spans, change and transition will continue -- changes in values, purposes, and circumstances. As adults, some will lose or change jobs, experience retraining, become successful, encounter illness, divorce or be divorced, develop and change emotional and spiritual perspectives, and adjust to retirement and the challenges of old age. Each of these events will signal a transition in their lives, some inevitable and predictable, many not. Forecasts for the future

signal the certainty of a far greater number of these life transitions for them than their predecessors ever dreamed of encountering. The educational system must help prepare students to cope with these realities by utilizing education as an instrument of change through which they may have the resources and options with which to build and survive the future.

Problem solving is receiving more national attention now than ever before. Daniels and Karmos (1983) found that except for the three R's, problem solving was listed most frequently in the literature and by employers as an essential skill for dealing with the future. Michael Timpane in his report of corporations and public education emphasized the need for teaching young people problem solving skills so they will be ready for further education and training (Timpane, 1982).

Not enough problem solving is occurring in classrooms. In the April 1983 Kappan, John Goodlad remarked that "teacher talk" was by far the dominant classroom activity. "Teachers rarely encouraged student-to-student dialogue or provided opportunities for students to work collaboratively in small groups or to plan, set goals, determine alternative ways of achieving these goals, and the like. The emphasis was on recall not on problem solving or inquiry" (p.552). Goodlad went on to say that each of the 50 states believes in problem solving instruction but very few are doing much with it.

Insufficient preparation in problem solving will have serious implications for many students. Roy Forbes, director of the assessment and evaluation division for the Education Commission of the States, predicted that by 1990 between 900,000 and 2 million high school graduates will not possess the problem solving skills required for employment in a highly technological society (Whimbey & Lochhead, 1984). For students to hold jobs, be retrained, and in general to adapt to a constantly accelerating rate of change in their lives, they will need strategies for how to attack and solve problems.

The model introduced above represents an extrapolation of available knowledge and opinion concerning the future of work and the skills that individuals will need if they are to find work in the future. The purpose of the remainder of this paper is to explicate teh model and to demonstrate its usefulness. This purpose will be achieved by:

summarizing predictions about the future of work and the requisite needs of employees, and identifying the implications of those predictions.

providing criteria for building a pretechnical curriculum which will be responsive to both the needs of employers and employees.

describing how the pretechnical curriculum may be implemented into the schools.

Future of Work: Employer and Employee Needs

Employers and employees have always had interrelated concerns about work. For employers, future concerns will revolve around the need to sustain state-of-the-art production and service capabilities in order to remain competitive within the market. For employees, future concerns will center on the need to find meaningful and satisfying employment and to adapt with changes that occur within or related to the work setting. Based on our review of the literature, however, a variety of different factors are predicted to disrupt the balance that exists between the concerns of employers and employees. Examples include the impact of technological change on the structure of the labor market, the increase in the transitory nature of work, and the emergence of participatory work environments in business and industry. As it will be demonstrated, each of these factors has important implications for the formulation of a pretechnical curriculum.

Structure of the Labor Market

One estimate of the net impact of technological changes has been provided by the AFL-CIO committee on the Evolution of Work (1983). This committee's report, based on reports from a variety of experts from business, industry, and public and private research institutions predicted the formation of a two-tier work force.

> As computers and robots take over more and more functions in the factory and the office, a two tier work force is developing. In some cases, jobs are being upgraded. In many other cases, jobs are being downgraded... At the top will be a few executives, scientists and engineers, professionals, and managers, performing high-level, creative, high-paid full time jobs in a good work environment... At the bottom

> will be low paid workers performing relatively simple, low-skill, dull, routine, high turnover jobs in a poor work environment. These jobs will often be a part of time and usually lacking job security and opportunities for career advancement. (p.8)

The AFL-CIO report continued by reporting two additional characteristics of their labor market projections:

> Between these two major tiers will be fewer and fewer permanent well-paid, full-time, skilled, semi-skilled, and craft production and maintenance jobs which in the past have offered hope and opportunity and upward mobility to workers... (p.4)
>
> Below the two-tier work force is a labor surplus underclass, the workers who don't have jobs and don't have job prospects. There is some movement in and out of this labor surplus underclass, but upward movement is essentially limited to the bottom level of the two-tier work force. (p.9)

Paul C. Craig (1984) of the Ohio State University stated that the work force of the future will require researchers and scientists and "a few highly skilled technical engineers and mechanical machine maintenance people... But the mass of people will not have advanced technical skills" (p.7).

Implicit within these predictions about the structure of the future labor market are assumptions about the types of occupations that will be available to the majority of individuals. The predominant assumption is that there will be increasing numbers of workers who will be limited to low-skilled, routine, high turnover jobs. Henry Levin (1984) of Stanford Unversity predicted that in the future the vast majority of jobs will be low level service occupations such as waiters, sales clerks, kitchen helpers, fast-food workers and cashiers" (p.4).

Rumberger (1984) contends that technological innovations will have a negative net impact on the structure of the future labor market. According to him it will not only reduce the total number of jobs, it will also reduce the skill requirements of most jobs. Moreover, others predict that the reduction of jobs and of skill requirements will be pervasive. It will affect not only specific occupations such as secretaries, bookkeepers, paralegal workers and repair people (Levin, 1984), but entire industries and occupations as well (Faddis, et.al., 1982).

In most instances, the redirection of jobs or skills requirements will involve the dislocation of workers and the incorporation of machines as technical equipment. The net result of this trend is that workers will be limited in both the number and variety of available occupations. Some workers will be able to obtain high tech positions (approximately 3 percent), but the remainder will be limited to occupations that will require only a high school education (Levin, 1984). Most of these jobs will lack security or opportunities for career advancement. In either situation workers will be confronted with the prospect of change; change that will affect not only their work, but almost every other aspect of their lives.

These projections about the structure of the future labor market have important implications for the formulation of a pretechnical curriculum. If it is designed to provide <u>everyone</u> with the capability to live successfully in a technological society, then it must prepare people to adapt with change. Schools need to prepare students to adapt with change. The importance and adaptability for high school graduates was emphasized in a recent report from the National Academy of Sciences entitled <u>High School and Changing Workplace: The Employers View</u> (1984). A panel of economists, educators and employers, "graduates of American high schools need to be adaptable to changes in the workplace more than they need any particular job skill.... This adaptability is by far the most important characteristic of the young person enter-

ing the workplace." (pp.xi-xii). A growing number of people believe that adaptability is most likely to be achieved when students receive a solid basic education as opposed to one that has a narrow vocational focus (Levin, 1984; Rumberger, 1984; Levin & Rumberger, 1983; Lemons, 1984). Vocational education can make significant contributions to the goal of adaptability.

Transitory Nature of Work

Work is becoming increasingly transitory in nature. It can no longer be viewed as a static concept. According to Levin (1984) there are two reasons for this fact. First, we are entering a period of rapid technological change in which both entry-level and high-skill positions are being transformed, often in unpredictable ways. Second, no one can accurately predict which jobs will be available to any particular person over a career of four to five decades, nor can it be predicted which particular jobs or combination of jobs an individual will actually obtain among those that are available.

The certainty of technological change and the unpredictability of its outcomes coupled with the inaccuracy of job forcasting guarentees that most workers will change jobs several times during their lives. Change may be forced (e.g. jobs may be eliminated), or they may be selected (e.g. a new and different position may be accepted). In either instance, workers will be expected to make the necessary transitions both in their work and in their day-to-day living and the transitions will often involve being retrained to do a different job.

The importance of the potential for successful retraining as a necessary characteristic of future workers has been endorsed by industry. As Peter J. Elliman, the Vice-President and General Manager of Lucas Industries, a multinational conglomerate, put it:

> Todays industrial workers must never cease learning and growing. Regardless of what individuals have accomplished or learned up to a point

> in time, in five years their skills will be obsolete and they will have to be retrained . . .industrialists have to deal with their end products for forty-eight years; every five years we have to teach them a new skill. Furthermore, many of these people never really learned how to study effectively so that we can retrain them easily. (Elliman, 1983, p.4)

It appears that workers' best counter to the prospect of "dislocation due to technological innovation" is to exercise a primary human characteristic, the capacity to learn. The ability to apply previous learning to the process of retraining will the landmark characteristic of future workers. Those who possess the ability to learn again and again and again will be better prepared to meet the retraining demands of their employers. For them technological innovations will not seem so ominous. Theodore Schultz, the Nobel Prize winning economist put the issue as follows:

> Mankinds future is not preordained by space, energy, or cropland. It will be determined by the intelligent evolution of humanity... future workers will need to be generalists, flexible enough to change course and train for new careers with a minimum of disruption. (p.)

Given the transitory character of work, it appears that workers may enhance their employment opportunities if they have learned to learn (Toffler, 1970); that is, if they have prepared themselves to be retrainable. Yet, as Ashley, Zahniser and Connell (1984) have noted, many workers, especially dislocated workers, lack this essential skill.

> The dislocated workers who are currently suffering from the results of rapid industrial declines characteristically are unionized workers with senority in blue-collar jobs, who earned high wages in manufacturing

> industries. Among the dislocated, females and minorities often are the more disadvantaged and suffer greater economic hardships following the loss of their jobs. In general, many dislocated workers, particularly the older workers, are lacking in their educational backgrounds and do not have skills that are in demand in other occupations. (Ashley, et.al. p.ix)

For workers who have not learned to learn, who have not prepared themselves to be retrained, job dislocation represents only half of their trauma. The other half is relocation. For many dislocated workers the process of relocation is neither easy nor successful. There are many factors that contribute to this lack of success, including their lack of adequate educational background of skills that are in demand in other occupations. Dislocated workers are often ill-prepared to deal with the social, psychological and physical problems that accompany the loss of their positions. Their inability to resolve these work related problems frequently results in increased incidences of depression, grief, alienation, substance abuse, marital difficulties, heart disease, and other stress-related illnesses, including increased incidences of depression, grief, alienation, substance abuse, marital diffulties, heart disease, and other stress-related illness, such as increased rates of suicide (Ashley, et.al., 1984). Their lack of job flexibility is paralleled by a lack of flexibility in other areas of their lives. Among their many other needs that must be met if they are to be relocated, most dislocated workers will need to be retrained if they are to reenter the work force in new positions (Ashley, et.al., 1984; Lemons, 1984).

The plight of the dislocated worker has several important implcations for the articulation of a pretechnical curriculum. First, as Ashley, et.al. (1984) have noted, "future economic conditions and technological changes are likely to increase the numbers of adult workers who will face the problem of job

dislocation or skill obsolescence throughout their work lives." (p. xi) Second, the prospect of becoming a dislocated worker places special emphasis on the skills and knowledge that will enable individuals to learn, i.e. be retrained. Third, the skills and knowledge that individuals need to adapt with the transitory character of work will include those that relate to the social, psychological and physical problems that are associated with loss of position. Finally, as noted by Rumberger (1984), job displacement will occur at all levels of the economy, not just at the bottom. Thus, future workers need to possess the skill and knowledge that will enable them to participate fully and effectively in a transitory work force.

Participatory Work Environments

The emergence of participatory work environments which are characterized by the collaborative efforts of labor and management, the importance of personal involvement in the production process, and the full expression of one's humanity through one's work represents one of the important products of the revolution of high technology innovations. While this particular development may appear to be an anomaly of this particular technological age, it represents an altogether human reaction to an environment marked by rapid drastic change (Hedist, 1974, as noted by Wirth, 1984). The central theme of this trend, which is the importance of people, has been acknowledged by economic and labor theorists (Wirth, 1977; Schultz, ; Gyllenhammer, 1977) and by industrialists (Ellimar, 1983; Freiz, 1983). The thrust of the theme as stated by Gyllenhammer (1977) is as follows:

> People don't want to be subservient to machines and systems. They react to inhuman working conditions in very human ways: by job-hopping, absenteeism, apathetic attitudes, antagonism. The younger the worker is, the stronger his or her reactions are likely to be. People entering the work force today have received more education than ever before in history.

> We have educated them to regard themselves as mature adults, capable of making their own choices. Then we offer them virtually no choice in our overorganized industrial units. For eight hours a day they are regarded as children, ciphers, or potential problems and managed and controlled accordingly. (p.4)

One alternative to a machine or system centered industry is one that is person centered. A person-centered industry has different economic and industrial assumptions. From an economic perpective, it assumes "a new economics which starts from a committment to make the fullest practicable use of whatever talents are inside people instead of starting from a consideration of the most profitable use or misuse of the elements inside the thin and fragile crust of the planet (Wirth, 1977, p.). From an industrial perspective, it assumes a commitment to obtaining the key elements that workers and managers need if they are to create "good work" for themselves (Wirth, 1981). Examples include:

> Adequate elbow room. Enough room to feel autonomous, but not so much room as to seem disconnected from the overall task.
>
> Chances of learning on the job on a continuous basis.
>
> An optimal level of variety.
>
> Conditions that promote help and respect among co-workers.
>
> A sense of one's own work meaningfully contributing to the welfare of society.
>
> A desirable future.

The collective goals of a person-centered work place have been translated to the American work place through Quality of Work Life (QWL) developments (Pratzner, 1984). According to Pratzner (1984):

> QWL developments embody a philosophy, a set of values and models, and a multitude of practices and techniques for understanding, explaining, and affecting how work is organized and carried out. QWL developments and participative management are democratizing the work place and involving employees in more decisions that effect their work, through the use of quality circles, problem-solving task forces, labor management committees, group incentive plans, job redesign, and a variety of other approaches and techniques. (p.3).

Quality of Work Life programs create two broad areas of job skill demands for employees: group problem solving and the organization and management of production (Pratzner & Russell, 1983). Group problem solving incorporates a number of other specific skills, including interpersonal skills, group process skills, decision making, communication and reasoning. Organization and management of production also includes a collection of specific skills. Examples include business economics, management, statistical quality control, and introduction to QWL.

Considered collectively, these several skills represent the foundation of socio-technical literacy (Pratzner, 1984). According to Pratzner:

> socio-technical literacy emphasizes a balanced concern for the social, human aspects of work, as well as the technological aspects, and an appreciation of their interactions. It includes development of (1) group problem solving skills (eg. interpersonal and group process skills, problem solving and decision making, planning, and communication), and (2) skills in the organization and management of production (eg. skills in business economics, business operation, and statistical quality control). It also includes (3) an understanding of the philosophical under-

pinnings and consequences of the shift from a mechnaistic, technological, scientific management perspective of work to a high envolvement, participative management perspective. (p.56).

Quality of Work Life programs are changing the characteristics of work by influencing the ways in which workers relate to one another and relate to management and to the production process itself. Programs of this type require employees with sufficient socio-technical literacy to make such efforts effective. Socio-technical literacy transcends the performance of a single specific job, or the operation of a particular piece of equipment, or a certain part of the production process. Its focus is more broad and includes the human and business aspects of production, as well as the technological aspects. The essence of socio-technical literacy is contained in the following description of an ideal worker:

> I am looking for individuals who can read and write...My ideal worker would also have common sense, understand my industry, be willing to accept that he or she will not reach the top in a year, and realize that he or she will have to work hard for the rest of his or her life...who will accept me as an ally and not as an enemy. I want this person to have been taught some of the basic social graces. (Elliman, 1983, p. 10)

The emergence of QWL programs also has important implications for the formulation of a pretechnical curricula. Assuming that QWL programs will remain an important dimension of high involvement industries, the demand for socio-technical literate workers will increase.

Summary

Three factors which are predicted to influence the future of work were discussed. They were the impact of technological change on the structure of the labor market, the increase in the transitory nature of work, and the emergence of participatory work environments. Each of these factors has important implications for the development of a pretechnical curriculum. A summary of the specific conclusions of this section and the implications of those conclusions for the formulation of a pretechnical curricula are listed below.

Conclusions	Implications
- Technological innovations will create new jobs in high-tech occupations; there will also be an increase in the number of low-skilled jobs.	- A pretechnical curriculum must be able to address the needs of both types of workers.
- Most workers will change jobs or occupations several times during their lifetimes, which will require them to be periodically retrained.	- A pretechnical curriculum needs to emphasize the skills and knowledge that will allow workers to benefit from retraining programs.
- For most workers, occupational changes will involve differing types of psychological problems which may limit their future employment opportunities.	- A pretechnical curriculum must minimally prepare future workers to understand and cope with the psychological problems associated with occupational changes.
- QWL programs are placing new skill demands on workers, including group problem solving and the organization and	- A pretechnical curriculum must prepare students to participate successfully in the work place, thus it

management of production. They are also helping to change the basic character of the work place.

must be responsive to the new skill demands that are experienced by workers.

Criteria for Curricular Decisions

Utility and Personal Options

High Tech innovations are expected to cause substantial changes in the structure of the labor market as well as in the characteristics of work settings. These changes have led us to challenge traditional approaches to vocational curricula such as specialized job-skill training programs and to set forth new criteria for judging secondary vocational educational curricula. The four criteria are: utilty, personal options, transferability, and psychosocial value.

It is an important task for vocational educators to identify a body of knowledge and skills that individuals must possess to live adaptively and effectively in a technological world. How does the content of a pretechnical curricula do this? It is our position that a pretechnical curricula will contribute to adaptability of individuals to the degree that they recognize the utility of the curricula for their personal situations. The criteria of utility, then, represents one basis for identifying the core skills and knowledge that will be needed by individuals if they are to live and work fully and effectively in a technological world.

Utility, however, will mean different things to different people. For some, utility may represent the assurance of employment in an entry level position in a particular business or industry. For others, utility may mean receiving skills and knowledge which are prerequisites for post-secondary training in a specific technological field. Still others may view utility as the skills and knowledge that will give the assurance of career flexibility throughout their lifetime. A pretechnical curriculum must be responsive to each personal definition of utility.

Personal option is a second criteria for identifying the contents of a pretechnical curriculum. It is seen as the condition of having an array of aptions from

which to choose. Personal options in one's work should give a wide domain of alternatives to choose from so that people can try to reflect their own interests, values, and strivings in the work they do. For one's job tc reflect one's self would be an immense benefit for people.

Taken together, the criteria of utility and personal option represent a practical basis for indetifying the content of a pretechnical curricula. The essence of this process has been expressed by Levin (1984)

> We cannot predict accurately which jobs will be available to any particular person over a career of four to five decades, nor can we predict which particular job or combination of jobs an individual will actually obtain among those that are available. Given these circumstances, education must be provided that will allow individuals the option to starting at entry level in the available occupations, and of undertaking education and training as needed in order to move into higher level occupations. (p.21 emphasis added)

Transferability

Tranferability of educational outcomes to the work place has drawn the attention to researchers who have attempted to identify those skills that are transferable from school to work (Greenan, 1983) and across work settings (Pratzner, 1978). After investigating the relationship between occupational adaptability and tranferable skills Pratzner (1978) concluded the following:

> Schools cannot prepare students for all unknown future contingencies. But it does seem reasonable to expect them to help students develop their individual attributes, potentials, or capacities to levels of proficiency useful in a wide range of situations. By such development they may be adaptable and better able to perform successfully in changing environments.

> Having transferable skills will not guarantee successful adaptability, but should facilitate it. To the extent that individuals perceive similarities among jobs and are able to transfer their skills and knowledge effectively, the time and costs associated with supplemental training or retraining should be reduced and reflect a savings to employers and individuals alike. (p.).

A good deal of research has focused on the identification of the skills and knowledge that are useable across a wide range of situations. One of the more recent and carefully defined investigations was completed by Greenan (1983).

Greenan's research focused on the generalizability of certain basic skills across different vocations. For Greenan, a skill is generalizable if it is basic to a particular occupation or training program, if it is necessary for success in a particular occupation or completion of a particular program, and if it is applicable across occupational settings and clusters. Greenan developed an instrument to measure the generalizability of specific skills in each of the following catagories: Mathematics, Communication, Interpersonal Relations, and Reasoning. The instrument was administered to teachers in five vocational training areas (agricultural occupations; business, marketing, and management occupations; health occupations; home economic occupations; and industrial occupations). Based on the results of his study, Greenan (1983) concluded that

> "There is a core of mathematics, communication, interpersonal relations and reasoning skills which are basic to, necessary for success in, and transferable across several secondary vocational training program areas and programs; most of these core skills are very important and highly generalizable..." (p.57)

The importance of transferability has also been recognized by industrialists. Elliman (1983) stated that:

> I would much prefer that the schools concentrate on teaching students the basic transferable vocational skills that they will need when I teach them the applied technology I utilize. The basics are the skills that business and industry can most capitalize on in years to come. (p.4)

The criterion of transferability is a necessary but not sufficient criterion by which to assess curriculum content. Utility can become too narrow a criteria by which to evaluate curricula content. A curricula that has utility may have students learning to use specific tools, repair highly specialized equipment, or gather specific types of data. On the other hand, transferability in a curriculum implies that a student may learn to use tools which are applicable across many jobs or job clusters, repair equipment which is used in many areas, and gather data in many ways using microprocessors, computers, and electronic data processing. Transferability helps students work and learn, be more easily retrained, and gain confidence that change is not an overwhelming threat but merely a part of one's life.

Psychosocial Value:

It is increasingly clear that job preparation for the future will have to influence information and skills that are related to the psychosocial issues of work and work loss (Baker, 1982). Several factors contribute to the emergence of this need: the development of QWL programs (Pratzner & Russell, 1983), the incidence of worker dislocation and its subsequent psychological stresses (Ashley, et.al., 1984), the prospect of multiple changes in job or occupation in a lifetime (Levin, 1984), and the need for individuals to participate fully

in a rapidly changing society (Rumberger, 1983). Future workers will need to be prepared to cope with these and other work related factors that involve psychosocial issues.

It may be presumptuous to assume that every worker will have a difficult time dealing with psychosocial issues that will confront them. Nevertheless, the criteria of utility, personal option, and transferability point to the necessity of systematically including psychosocial content within a pretechnical curriculum. At a minimum the psychosocial content must focus on the development of character (Silberman, 1983), on individual problem solving, group decision making (Pratzner, 1984), and on managing transitions (Brammer & Abrego, 1981).

According to Silberman (1983) "the acquisition of appropriate personal skills and attitudes is just as important outcome of vocational education as is the acquisition of technical and basic literacy skills." (p.). Frequently mentioned personal attributes are autonomy, courage, and cooperativeness. For Silberman (1983), autonomy refers to the ability to act as a mature, rational, inner-directed, independent person and to be responsible for one's own actions. Autonomous people think before they act, and require minimal supervision. They can forego short-term gratification in favor of long-term lasting benefits. They are also capable of self-directed learning. He defines courage as the ability to overcome fears and to confront problems directly--doing what is necessary even if the actions are unpopular. People with courage have the ability to cope with problem situations or emergencies. Such people do their duty when long-term interests are at stake even when the short-term consequences may be aversive. They are self-confident and not afraid to seek help from others when they need it. Finally, Silberman (1983) uses cooperativeness to describe workers who are warm, friendly, and supportive. People who are prompt, dependable, loyal to the group, and conform to group norms in their dress, manners, and personal habits

are traits which enhance group membership. They possess good interpersonal skills, good work habits, and positive attitudes. They accept supervision, and their behavior is consistent with the orderly conduct of business. They have good interpersonal relations and share a strong sense of community.

Acquisition of the characteristics described within these three attributes represent a potential for personal development within a pretechnical curriculum. Having the personal qualities of being self-directed and responsible, self-confident and responsive, interrelated and participative with others appears to have great utility for present as well as future workers. It is this utility that magnifies the importance of including psychosocial skills and knowledge in a pretechnical curriculum.

The personal qualities that are important for workers to possess which were identified by Silberman (1983) are not dissimilar from the requisite QWL skills identified by Pratzner & Russell (1983). As noted earlier in this paper, QWL programs represent an alternative for organizing and performing work. They require that workers possess new and different sets of skills and knowledge, including individual problem solving skills and group problem solving skills, and the skills to organize and manage production. These represent the foundation of socio-technical literacy which emphasizes a balanced concern for the social and human aspects of work as well as the technological aspects, and an appreciation of their interactions (Pratzner, 1984).

Applying the Criteria to Programs

The Center for Occupational Research and Development (CORD) (1983) has developed a curricula that contains utiltiy and transferability through basic skills and incorporates personal options through advanced courses. After demonstrating a suitable proficiency in the requisite skills, individuals complet-

ing the CORD curriculum begin a technical curriculum which encompasses twelve core areas (eg. electricity, mechanics, materials, thermics, etc.). After completing this technical core, students study a self-selected high tech area.

According to current estimates, the CORD curriculum is suitable for one out of every 10 students (AFL-CIO, 1982). CORD lacks transferability across a sufficiently wide range of different job clusters and it lacks psychosocial value because the material does not adequately emphasize the development of the human potential and self-empowerment of workers.

Other programs, in addition to CORD, have also been reviewed. Table 1 below summarizes our evaluations of them relative to the four criteria of utility, personal options, tranferability, and psychosocial value.

TABLE 1

Four Criteria Applied to Curricular Programs

	Utility	Personal Options	Transferability	Psychosocial Value
CORD	X	X		
State of Arizona	X		X	
Canada Life Skills	X	X	X	
San Diego Program	X		X	

Note to Bill: We shall extend this list in the final version.

Summary

The curricular content of vocational education has always had an important role in the preparation of secondary students for work. Traditionally the curriculum has been related to specialized job skills training. Recent technological innovations, and their resultant impact on the world of work, create the need to reevaluate the traditional curriculum against the four criteria of: utility, personal options, transferability, and psychosocial value. Such criteria have important implications for the formulation of a pretechnical curriculum. These criteria coupled with our experience with current writings, views of education, business people, teachers, students, and unemployment victims have led us to three categories of essential skills for helping people to cope with their work-lives: Generalizable Skills, Transition Skills, and Problem Solving Skills. There is self-empowerment in these skills. It can be seen that the stated need for inclusion of Generalizable Skills in the vocational education curricula satisfies the criteria of transferability and personal utility. The inclusion of the category of Problem Solving Skills satisfies the criteria of transferability, personal option and psychosocial value. Transition Skills satisfy the criteria of transferability, psychosocial value and personal utility. It is the interrelatedness of these three categories of skills which provide a comprehensive framework for self-empowerment of the individual and curricula decisions. Self-empowerment is the key assumption for guiding schools in preparing your people for their futures. People can help themselves to lead more meaningful, balanced and productive lives.

It is ultimately the individual who must apply the new techniques in the workplace. People must not become slaves of technology and change. A machine, a process, a system is no more effective than the people using it. The human factor in education and work must stand above all others.

Transitions

During the last decade educators have been made aware that students lives are marked by change and transition. Forecasts for the future signal the certainty of greater numbers of life transitions. Occupationally related transitions will become the rule rather than the exception for most workers. They will interact with and be further intensified by the transitions which have resulted from changes in societal norms (Naisbitt, 1983). Educators cannot be expected to prepare students for all possible unknown future contingencies. Nevertheless, as noted by the National Academy of Sciences (1984), society, business, and industry will expect educators to help students develop skills which will prepare them to cope, adapt and change with their environment. The person-machine-change relationship is critical to the successful management of the future for students, educators, business and industry. It is for this purpose that the class of Transition Skills has been identified and a framework for educating for attainment of those skills introduced. The aim of this class of skills is consistent with the image of vocational educators serving the needs of employers, the labor market and the individual. It maximizes the preparation of the individual for a life time of transitions.

A transition results in changes in relationships, routines, assumptions, or rules within the setting of self, work, family, school, health, or finances (Schlossberg, 1984).

The U.S. economy is undergoing a major restructuring, and the implications for the individual worker are serious. As a result of foreign competition, changing world markets, and consumer preferences, American's economic position

in the world has eroded and many workers in some major manufacturing industries including steel, automobiles, rubber, textiles, radio and television receivers, and electrical equipment have lost their jobs and have been forced to suddenly change their occupations and life styles (Pratzner & Ashley, 1984, p. 5). Simultaneously, the advent of high technology insures continued and accelerated change in the nature of available jobs.

> The increased use of industrial robots, office automation, microelectronic devices, and computerized information and telecommunications systems, will not only affect where and how we live, and what we purchase, but also how we work. The impact of changing technology, expecially the continued expansion of computer applications in the work place, will affect the skill requirements and work styles of millions of workers over the next ten to twenty years. New technology will in some cases reduce the skill requirements of some occupations, especially those involved with more routine and repetitive functions such as parts assembly, equipment operations, signal monitoring, and information handling functions. Other occupations involving the functions of planning, evaluating, analyzing, interpreting, troubleshooting, and maintaining complex systems will likely experience an increase in skill requirements (Pratzner & Ashley, 1984, pp. 5-6).

Change is increasing in our social institutions and will continue to increase. Traditional roles of men and women are being more rapidly transformed, more women are entering the workforce, family units tend to have less stability, and traditional values and practices are continually

challenged and rejected by some segments of the population and renewed by others. Occupationally-related transitions will interact and be intensified by transitions resulting from such changes in societal norms and trends which began in the 60's and now are becoming commonplace in our society. Imagine, for example, the coping skills needed by a person who must relocate in order to maintain present income at the same time that such a move would be detrimental to the spouse's occupational progress. Life transitions are no longer as predictable as they once were, and they tend to be more complex. Accordingly, skills for managing transitions will become increasingly important for our young people as they enter a work world and a social world in which acceleration of change is the only predictable variable in their future lives. To survive, individuals will have to learn new ways to adapt and new ways to cope with their environment.

The educational system must help prepare students to cope with these realities by utilizing education as an instrument of change through which they may have the resources and options with which to build and survive the future. The challenge for educators seems overwhelming as powerful alternatives to public schooling threaten to change the social context of education. The idea of sociotechnical literacy (Pratzner, 1984) no longer rests on the teaching of a fixed body of information in a fixed routine but instead on the incorporation of ways of transforming students' abilities to function in a changing world, to learn how to learn for a lifetime, to cope, manage, and adapt to the challenge of an uncertain future. It is the responsibility of educators to identify and pass on those skills.

The class of Transition Skills refers to those skills which are used to manage life transitions, especially occupationally related ones. Subsumed within this class of skills are those which include managing changes

in environment, relationships and the self; managing stress, loss, and grief; and making decisions. The framework below is an attempt to introduce a comprehensive approach to handling transitions which may be incorporated in the public school curriculum and a) utilizes an understanding of adolescent development, b) organizes the knowledge and process necessary for maximizing an individual's ability to adapt and manage transitions across settings (personal, interpersonal, workplace, institutional, or community) and c) focuses on the self empowerment of the individual to understand and deal with events as they occur.

Managing transitions depends upon people's ability to successfully acquire and mobilize the skills that will enable them to adapt with change. These skills are identified in each step of the framework. Each step of the framework focuses on acquisition of a series of skills which maximizes management of transitions and prepares the individual to manage future ones. The four steps identified in this framework are:

Step 1. Identify the Transition

Step 2. Identify Coping Resources

Step 3. Identify and Choose Ways of Managing the Transition

Step 4. Trial, Integration, and Self-Transformation

The framework, as it exists may be utilized by educators either through a questioning format (see Expanded Model) or through development of curricula based upon the understanding of the four steps of the framwork (Table 1). The introduction of the framework will be accomplished through the (a) presentation of the Expanded Model, (b) presentation of the Framework for Incorporating Transition Skills into the Curricula, and (c) presentation of a simulation which represents a viable instructional method for teaching transition skills as well as a format for clarifying the four steps of the framework. The expanded

framework consists of a series of questions which attempt to accomplish the outcome variable of each step. The Framework for Incorporating Transition Skills into Curricula (Table 1) identifies the components of the framework with requisite skills and outcome variables. The simulation represents a synthesis of the skills and outcome variables as they are utilized relative to a real-life setting.

Framework for Incorporating
Transition Skills into the Curricula

Components of Framework	Skills Necessary to Attain Mastery of Individual Component of the Framework	Outcome Variable
	The individual will:	
I. Identify the Transition	- Identify Type of Transition A. Anticipated/Developmental B. Unanticipated C. Chronic Hassle (Schlossberg, 1984) - Identify Setting A. Self B. Family C. Work D. Health - Identify Relationship of Person to the Transition A. Self B. Other C. Interpersonal D. Community	- Assessment of Stress - Assessment of Impact of Event on Assumpt
II. Identify Coping Resources	- Identify Support Systems A. Internal B. External - Identify Possible and Actual Coping Responses A. Immediate/Short Term B. Future/Long Term - Assess Impact of Personal Variables A. Socioeconomic status B. Psychological Resources (Development - Ego Strength) C. Committments, Values	- Mobilization of Resources Necessary to Assist in Management of Transition - Identification of Needs which must be me to Cope and Adapt - Enhancement of Personal Awarenesses Necessary to Respond to Transition - Regaining Control Over Stress and Meanin of Transition

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Components of Framework	Skills Necessary to Attain Mastery of Individual Component Framework	Outcome Variable
I. Identify and Choose Ways of Managing the Transition	- Examine and Identify Alternatives for Coping A. Support Groups B. Counseling C. Restructuring Support System D. Learn New Coping Skills (Exercise, Relaxation, Time Management) - Utilize Problem Solving Model A. Identify Problem B. Brainstorm Possible Solutions C. Choose Tentative Solution D. Carry out Tentative Solution E. Learn - Utilize "Neutral Zone" A. Identify What You Really Want B. Find Time To Be Alone	- Increase Ability to Make Effective Decisio Regarding the Transition - Increase Awareness of the Options For Transition Management - Increase Ability to Reapproach Work, Love, Play with Renewed Energy
IV. Trial, Integration, Self Renewal	- Act Upon Identified Coping Strategy - Identify Learnings From the Transtion A. About Self B. Others C. Assumptions - Evaluate Action - Reevaluate Plan If Necessary	- Learn From Current Transitions Ways of Transferring Skills to Future Transitions - Discover Strengths About the Self - Return to Equilibrium of Pretransition Environment

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Model for Handling Transitions

I. IDENTIFY THE TRANSITIONS

- What has ended? (something personal, interpersonal, family, school, friends)
- How much stress are you under? What is causing it?
- What fears do you have? Be specific.
- Describe the transition as best as you can.
- What kinds of things are changing in your life? (people, job, school, values)
- What is the impact on you? How do you feel about the transition?

II. IDENTIFY COPING RESOURCES

- Who can help you?
- Who could provide a personal support network? (emotional, physical, group, individual)
- How can you help yourself?
- What are some of your options? List them.
- Will preplanning help you cope with the hardest part of the transition?
- Remember the 5 main steps for solving a problem.
  1) Understand the problem (transition).
  2) Brainstorm for solutions.
  3) Choose a tentative solution.
  4) Implement the solution.
  5) What did you learn?
- What obstacles do you have to overcome in order to change? (financial, psychological, interpersonal)
- How might you benefit or not benefit from the transition?

III. IDENTIFY AND CHOOSE WAYS OF MANAGING THE TRANSITION

a) What are various alternative actions for coping?

° Maybe a problem has to be solved. If so, use the 5-step model.

° Individual or group counseling is always a possibility.

° Do you need to learn new coping skills? (relaxation skills, exercise program, time management, health care, etc.)

b) Examine the positive and negative consequences of all planned actions.

c) Are you taking full advantage of the "Neutral Zone"?

° Find a regular time to be alone and to reflect on the transition.

° Identify what you really want.

° Reexamine your values and your goals.

d) What do you know about yourself that you can use in managing the transition?

IV. TRIAL, INTEGRATION AND SELF-TRANSFORMATION

° As you try things out, who can you discuss them with?

° In what ways is this a positive experience? A negative one?

° How are you different?

° What did you learn from this experience? What did you learn about yourself?

° Is your grief or disappointment part of a healing process?

° What are some options open to you if you think you are not managing the transition well?

° Can you accept the transition and go on with your life?

Simulation:

The following represents a simulation used with counselors of displaced workers. This simulation is based upon the topic of loss of a job, but is easily adaptable to reassignment or retraining. Each step of the transition framework will be identified and clarified during discussion of the simulation Space constraints prohibit an in-depth discussion of the theoretical foundation and some of the transition framework.

Step 1: Identify the transition

Every transition begins with an ending (Bridges, 1980). That is an event occurs which signals an end of the way things were. Workers who have lost their jobs face the end of worklife as they have known it and face the uncertainty of unemployment, retraining, changes in self image, and changes in homelife.

Assessment of stress and impact of the transition on individuals' assumptions about themselves is the necessary outcome of this component. This assessment may be accomplished by identifying (a) the type of transition, (b) the setting and (c) the relationship of the person to the transition. The type of transition generally associated with job loss is an unanticipated event. An unanticipated transition is a nonscheduled event and generally is not predictable. This is different than an anticipated transition which may occur predictably over a life span and is more developmentally related; for example, graduating from a technical program, getting a first job, or getting married.

To identify the transition setting the individual examines the primary arena in which the event is based. Loss of a job takes place initially in the setting of work, but the stressors of job loss soon impact upon all other

identified settings (self, family, health, economics). The relationship of a person to the transition is central to assessment of the impact of the transition on an individual's assumptions. For example, loss of one's job is more stressful than having a friend lose a job.

Step 2: Identify coping resources.

The process of coping with transitions provides the individual with the ability to manage future transitions. Step two is specifically designed to enhance the personal awarenesses necessary to maximize one's ability to adapt and respond to transition and allows the individual to regain control and meaning of the transition. To accomplish this the worker who has lost a job may first identify the support system - internal and external.

Initially an individual may rely solely on a spouse or immediate family members to provide emotional support; however, optimumly this support system may need to expand the support-system to include other options such as; friends, relatives, clergy or support groups which deal with the effects of structural unemployment.

Second, identify possible and actual coping responses. Initially, an individual who has lost a job may experience a range of responses which are an attempt to modify, control or manage the stress (Pearlin and Schooler (1978). Such responses as anger, hostility, denial and anxiety are common. As time passes responses of depression, sadness, isolation, withdrawal and apathy become more prevalent. These coping responses represent but a few options available to the individual and translate into behaviors which an individual does in their own behalf when confronted with change. Third, the worker may also assess the impact of personal variable on the transition.

Psychological resources, personal and financial commitments, and values an individual has will also impact on the individual's ability to regain control over the stress of the transition.

Step 3: Identify and Choose Ways of Managing the Transition.

At this stage the displaced worker proactively goes about examining and identifying alternatives for coping with the job loss. The worker may utilize a support group or choose to learn new coping skills and then utilize the problem solving model to deal with specifics of a job search, money management or family relationships. This component is essential to increase the individual's awareness of options for transition management, to increase the ability to make effective decisions regarding the transition, and to increase the motivation to reapproach work, love, and play with renewed energy.

The utilization of the "Neutral Zone" in this stage is a time-out from the proactive approach to transition management. The purpose of the "Neutral Zone" is to reflect on what the individual might really want. It is a time to reexamine how ones values and goals integrate with the decisions about to be made. For example, the individual who has lost a job may discover that several options are available-going back to school to enhance skills, moving to a different location for a similar job, or retraining with the same company for a different job. After going through Steps 2 and 3 of the framework, the individual is aware of the consequences, advantages and disadvantages of each choice. Entering the "neutral Zone" gives the individual time to think about the choices to be made.

Step 4: Trial, Integration and Self-Transformation.

This step begins with the implementation of the decision. If the individual who lost a job chooses to return to school for training there are a number of new experiences , people, and environments that will be encountered.

Knowing how to utilize the support system that was identified in Step 2 may be paramount. Awareness and evaluation of the experience of the decision is a necessary componant of Step 4. The individual may realize that the first choice for managing the transition is not appropriate and need to return to Steps 2 or 3 to choose again or change options..

If the individual finds the first option appropriate, it becomes necessary to evaluate what one learned from the transition, how one is different as a result of the transition, what strengths one possessed that aided in transition management, and the degree of acceptance one has for the transition.

Utilizing Step 4 of the transition model enables the individual to return to the equilibr ium that was experienced in the pre-transition environment with renewed awareness and skills necessary to cope, manage and adapt to future transition and change.

PROBLEM SOLVING

The importance of problem solving in vocational education is receiving more national attention now than ever before. For example, Daniels and Karmos (1983) found that except for the three R's, problem solving was listed most frequently in the literature and by employers as an essential skill for dealing with the future. Pratzner (1984) has stated that "The first priority is for secondary level vocational education to offer good education in reading, writing, computing, listening, and problem solving" (p.6).

Ann Brown from the University of Illinois conducted an interview with Edward Binet (Brown, 1984) on the teaching of problem solving skills: Binet said:

> What I object to in traditional classes is that it is the teacher who produces, and the student who passively listens. Such a lesson has two faults: it does not impress the student other than by its verbal function, it gives him words instead of making him deal with actual objects, and it appeals only to his memory, reducing him to a passive state. He doesn't judge, doesn't think, doesn't invent, and doesn't produce. He needs only to retain. His aim is to repeat without mistake, make his memory work, know what is in the lecture, in the textbook and reproduce it. The result of such practices are deplorable: e.g., a lack of curiosity for what is not in the book or lecture; a tendency to look for the truth only in the book, the belief that one is doing some original research by going through a book, too much respect for the writer's opinion, a lack of interest in the world and the lessons it gives, a naive belief in the power of simple formulas, a difficulty to adapt oneself to contemporary life, and, above all,

a static regimentation unwelcome at a period when social evolution is so fast. (pp. 14-15).

Something is being done about problem solving by business and industry. In 1983, General Motors trained approximately 50 percent of its employees in problem solving skills. Kathy Long, Director of Research and Development for GM, said in a personal interview (1983) that the training has been successful, that productivity and positive attitudes have both increased, and that General Motors is going to devote more time and money to problem solving training. The training has improved worker competency, enabled workers to diagnose and solve job-related problems, taught them to examine their own behavior and consequences of it, and has helped workers to be more cooperative with each other in solving problems (Guest, 1979). The Center for Public Resources, in its report Basic Skills in the United States Work Force (1982), identified other corporations and also schools which are currently involved in problem solving training.

A Model for Problem Solving

For students to hold jobs, to be retrained and in general to adapt to a constantly accelerating rate of change in their lives, they will need strategies for how to attack and solve problems. Possession of at least one general model for solving problems is one essential strategy. There are many different models. The one we have developed is given below. It is based on problem solving models from General Motors (Kolb & Baker, 1980), from G. Polya's book How to Solve It (1957), and from Thomas Gordon's book Teacher Effectiveness Training (1974). Our model has five steps.

Five Step Model for Solving Problems

1. Understand the Problem

   - o If people are involved, then there should be explicit agreement among the people on what the problem is.
   - o If appropriate, analyze the problem for possible causes. (In mathematics causes are usually not involved.)

2. Brainstorm for Possible Solution Strategies

   - o No evaluations or judgments should occur here. This should be a free-wheeling act of generating ideas.

3. Choose a Tentative Solution Strategy

   - o For "people" problems, consequences of behaviors and solutions must be carefully considered.
   - o If people are working out an interpersonal problem, then the tentative strategy will likely be a compromise.

4. Carry Out the Tentative Strategy

   - o In implementing most strategies involving people, it is important to decide, "Who, does What, When."

5. Learn

   - o Immediately and over time think about what can be learned from the experience. What are the implications of what has been done?
   - o If appropriate, evaluate the effectiveness of the solution. (You may have to start over.)

At the beginning, we have our students follow the Five Step Model, step by step. Later on they are encouraged to freely use their own creativity and intuition to solve problems since no single model is directly applicable to all problems.

The Five Step Model is currently being used by students for their academic work and for their interpersonal lives. But is the model also practical for the work place? The answer is "yes". Students use it in their part-time jobs, and General Motors uses it to get people to work together to solve problems. Employees cooperate in GM's Employee Participation Groups to solve on-the-job-problems. In a 1983 personal interview, Kathy York of GM's Research and Development Division stated that competition among workers often turns out to be a liability. "They work separately against each other. We need our employees to work together to solve problems. That will increase their job competence." The problems that the groups focus on are not generally psychological ones; they are job-related problems. Workers, supervisors, managers, and executives get involved in the groups. Whoever is being affected by the problem or the solution is in the group. They use a model very similar to the Five Step Model.

The Need for Transfer

For general problem solving, a model is necessary but it is not sufficient. Transfer is one of the deficiencies. Schools teach problem solving, but most students have difficulty transferring their problem solving capabilities from one setting to another (Johnson, 1984; Snowman, 1984). We believe there are tow major reasons for lack of transfer:

1. Not enough diverse kinds of problems are given to students to encourage transfer over a wide range of settings. Only math problems are given, or science problems, or social studies problems, and so on. These problems are context bound. They are too similar to each other. There are many commerical programs for teaching problem solving, and they provide a wide variety of problems. The June 1983 issue of the Kappan listed more than 30 programs, video-taped presentations, computer-assisted instruction, instructional programs for teachers, and materials for student use. Other excellent sources are:

   - The Edward deBono School of Thinking, P.O. Box 711, Larchmont, NY 10538.
   - Institute of the Advancement of Philosophy for Children, Montclair State College, Upper Montclair, NJ 07043.
   - The Productive Thinking Program from the Charles E. Merrill Publishing Company in Columbus, OH.
   - Problem Solving and Comprehension by Arthur Whimbey and Jack Lochhead, The Franklin Institute Press, Philadelphia, PA, 1979.
   - More Life Skills by Joan Hearn, Advanced Development Division, Employment and Immigration, Ottawa, Canada, K1A 0J9, 1982.
   - Problem Solving in School Mathematics, 1980 Yearbook, National Council of Teachers of Mathematics, Reston, VA.
   - Instrumental Enrichment by Reuven Feuerstein, University Park Press, Baltimore, MD, 1980.
   - The New MCAT Student Manual (Quantitative Skills) from the Association of American Medical Colleges, Washington, DC, 1984.
   - Medical College Admission Test (Quantitative Skills) by Morris Bramson and Lawrence Solomon, Arco Publishing, Inc., NY, 1982.
   - A Complete Preparation for the New MCAT, Vol. II (Quantitative Skills) by Beryl Brain, Drew Love, and Philip Kalleher, Health Professional Education Service, Inc., Bethesda, MD, 1981.

   If Molitor (1981) is right in his predictions that by the year 2000, 76% of the work force will be in information/knowledge/education enterprises and other services, then the last three references will be particularly good sources of problems to prepare students for the future.

2. Most students are not explicitly taught strategies for solving problems. Some strategies are: using a model, reading information carefully, breaking the problem into manageable parts, and making a sketch. We have taught strategies to students, they have learned them, and they have improved their problem solving.

Strategies for Solving Problems

General Guidelines for Problem Solving

Guidelines from deBono. Edward deBono has formulated guidelines for good thinking and problem solving. His system has been adopted by corporate executives, taught in schools, and studied by government officials from more than a score of countries. Here are basic tools taken mostly from deBono's The Learning To-Think Coursebook.

1. Consider All Factors and Don't Limit Perceptions

A conscious effort should be made to think of everything that might be relevant for solving the problem. Suppose you're thinking about buying a new house. Consider all factors to be sure you ask all the right questions. While obvious issues such as size, cost and layout are bound to come to mind, without a deliberate effort to list every relevant factor you might overlook others. How good is TV reception? Is there a local leash law? Can the pipes be drained quickly in case of a power failure in freezing weather?

Even after using various tools of thought, you may not have found a satisfactory solution to your problem. The key to finding alternatives is to look for possibilities outside your usual thinking patterns. Edison, in searching for a light-bulb filament, tried thousands of unlikely materials including cork, fishing line and tar, before succeeding with a strip of carbonized cardboard.

2. Consequences and Sequels

One of the traits that makes us different from animals is our ability to imagine the outcome of our actions. But we can greatly improve this ability by learning to use it in a systematic way. The deBono technique is to imagine the probably outcome of a decision at four distances in the future: immediate, short term (1 to 5 years), medium term (5 to 25 years) and long term (over 25 years). By weighing the consequences of thoughts and actions, people can be less impulsive and make better decisions for themselves, based upon careful thought and not on quick emotion.

3. Aims, Goals, Objectives

An often ususued tool of better thinking is the practice of making a list of reasons for doing a particular thing. Defining goals can also help lead to creative solutions to problems. DeBono tells of a grandmother trying to knit while her yarn was being tangled by the family toddler. Exasperated, she put him in his playpen, but he howled so loudly that she had to take him out. Then she realized that her goal wasn't to pen the child, but to separate him from her yarn. So she solved the problem by leaving him out--and climbing into the playpen herself.

4. Other Points of View

Often problems involve a conflict with someone such as a friend, parent, boyfriend, or girlfriend. It is the mark of a good problem solver to be able to find a solution that will agree with the other person's viewpoint. It is particularly difficult to do when one is upset or angry. But if you can take another person's point of view at such times, then you have one of the major skills of a good problem solver.

Guidelines from Whimbey and Lochhead

An additional set of guidelines for problem solvers is given by Arthur Whimbey and Jack Lochhead in Problem Solving and Comprehension. They describe the beliefs, practices, and tendencies of good problem solvers, and also the characteristics of poor problem solvers.

1. Positive Attitude

Good problem solvers have a strong belief that academic reasoning problems can be solved through careful, persistent analysis. Poor problem solvers, by contrast, frequently express the opinion that "either you know the answer to a problem or you don't know it, and if you don't know it you might as well give up or guess."

2. Thoroughly Understanding the Data and the Problem

Good problem solvers take great care to understand the facts and the relationships in a problem fully and accurately. They are almost compulsive in checking whether their understanding of a problem is correct and complete. By contrast, poor problem solvers generally lack such an intense concern about understanding. They frequently miss a problem because they do not know exactly what it states.

3. Breaking the Problem into Parts

Good problem solvers have learned that analyzing complex problems and ideas often consists of breaking the ideas into smaller steps. They have learned to attack a problem by starting at a point where they can make some sense of it, and then proceeding from there. In contrast, poor problem solvers have not learned the approach of breaking a complex problem into subproblems--dealing first with one step and then another.

4. Avoid Guessing

Poor problem solvers tend to jump to conclusions and guess answers without going through all the steps needed to make sure that the answers are accurate. Sometimes they make intutitive judgments in the middle of a problem without checking to see whether the judgments are correct. At other times they work a problem part of the way, but then give up on reasoning and guess on an answer. Good problem solvers tend to work problems from beginning to end in small, careful steps.

The tendency for poor problem solvers to make more errors--to work too hastily and sometimes skip steps--can be traced to the three characteristics already discussed. First, poor problem solvers do not strongly believe that persistent analysis is an effective way (in fact the only way) to deal with problems. Thus their motivation to persist in working an entire problem precisely and throughly, until it is completely solved, is weak.

Second, poor problem solvers tend to be careless in their reasoning. They have not developed the habit of continuously focusing and checking on the accuracy of their conclusions. And third, they have not learned to break a problem into parts and work it step-by-step. As a result of these three characteristics, poor problem solvers have a strong tendency to make hasty responses as they work academica reasoning problems, causing errors in both simple computations and in logic.

5. Activeness in Problem Solving

The final characteristic of good problem solvers is the tendency to be more active than poor problem solvers when dealing with problem solving. Put simply, they do more things as they deal with a problem. For example, if a written description is hard to follow, good problem solvers may try to create a mental picture of the ideas in order to "see" the situation better. If a presentation is lengthy, confusing, or vague, they try to pin it down in terms of familiar

experiences and concrete examples. Furthermore they will ask themselves questions about the problem, answer the questions, and "talk to themselves" as they try to clarify their thoughts. They may try a flow-chart, brainstorm for possibilities, write on the problem, make diagrams, or use other physical aids to thinking. All in all, good problem solvers are active in many ways which help them get a clearer understanding and how to progress through them.

The Problem Solver's Knowledge Base

Robert Glasser (1984) stated that the knowledge of novice problem solvers is organized around the literal objects explicitly given in a problem statement. Experts' knowledge, on the other hand, is organized around principles and abstractions that subsume these objects. The principles are not apparent in the problem statement but derive from knowledge about the things in the problem or the subject matter associated with the problem. Knowledge of dietetics is needed to solve problems of nutrition, knowledge of auto mechanics is needed to fix a car, and so on. The problem solving difficulty of novices can be attributed largely to the inadequacies of their knowledge bases and not to limitations in their processing capabilities, such as the inability to use problem-solving strategies. "Current studies of high levels of competence support the recommendation that a significant focus for understanding expert thinking and problem solving and its development is investigation of the characteristics and influence of organized knowledge structures that are required over long periods of time" (p.99). Reuren Feuerstein (1980, p.22) sums it up very well: "It is when cognitive processes become detached from specific tasks that cognitive structures are established. These structures are of a more general nature than the learning of specific tasks and, hence, result in more adaptive behavior by the individual."

Students with a wider knowledge base are better at brainstorming for solutions across a wide range of problems. They are more able to understand and construct analogies, they make more discoveries, they see patterns, and they establish new relationships.

Some Specific Problem Solving Strategies

There are other strategies that can help people become better problem solvers. The ones to be discussed here are: thinking aloud, using the trial and error method, working backwards, finding all the possiblities, managing time, logical and critical reasoning, and gathering, recording and analyzing data. We have taught these strategies to students and have witnessed students' growth in becoming confident and skillful problem solvers.

Thinking Aloud. When using this strategy, people say aloud their thoughts while attempting to solve a problem. All mental processing, however, need not be vocalized. For example, it is not reasonable to explain the meaning of every word read for a problem. When a student is unsure of what to do, confused by an idea, or stops for some time to think about it, then some thinking aloud may be appropriate. When the strategy is used, then students should try to think aloud as much as possible. Expressing thoughts, especially at sections of a problem where difficulties or hesitancy arise, is a good way to avoid skipping steps in reasoning, jumping over important information, or being unaware of the point at which being bogged down occurred.

Thinking aloud while solving problems requires practice. At first, many students find it difficult to vocalize their thoughts as they work problems. But students do get used to expressing in words the steps they take and gain confidence in "talking out" the problem in front of the teacher and other students. We use the technique in full class settings, in small groups, and

in one-to-one discussions between student and teacher. The choice of setting depends on the nature of the problem, the students, and the teacher.

From thinking aloud, our students have learned to listen to each other, to locate breakdowns in reasoning, to learn where the stumbling point is, to realize how different people approach the same problem, and to see more than one solution to the same problem on the blackboard at the same time. Students and teachers are often amazed at how much they can learn from each other by thinking aloud.

Trial and Error

Trial and error is often underestimated as a problem solving strategy, but it can be a key strategy in the solution of some problems. Trial and error can be applied systematically by simply trying different solutions to see if they work. More often than not, however, the search can be narrowed by taking into account relevant knowledge and, by inference, reducing the number of solutions to be tried. Trial and error can also be advantageous in getting a feel for a problem. Trying out a reasonable guess, even if it does not work, can give valuable information. For example, if trying to find a decimal approximation for the square root of two, one might try 1.5 (1 is too small because 1 x 1 = 1, and 2 is too big because 2 x 2 = 4). Since 1.5 x 1.5 = 2.25, 1.5 is too big but that is valuable information because it directs the next attempt to a number between 1 and 1.5. Teachers should encourage students to make reasonable guesses at times and should specify for them the value of what was learned from the trial and error and how the error can narrow the search for a solution.

This same way of thinking about the information gained from an imperfect attempt can be applied to solutions of interpersonal problems. Suppose a father and his daughter are problem solving about the condition of her room, particularly about the dirty clothes on the floor and on the furniture. An idea to try might be a clothes hamper in her room. Both would agree that it is a trial solution to be evaluated, say, in three weeks. If the solution is not the right one, the attempt still will help to clarify the problem and suggest a better solution.

One roadblock to becoming a good problem solver is reluctance to take a risk. Many adults have been conditioned over the years to believe that there is some strategy or way to proceed in solving a problem that they "should"

have learned, and if they can't "remember how to do this kind of problem," they simply give up. Teachers are confronted with this attitude frequently when their students complain that "we haven't had this yet." Indeed, there are many specific approaches to problems that can be learned. But good problem solvers are not hampered by the conviction that there is only one way to solve a problem. They do not rely on some outside authority, but have confidence in their own ability to generate ideas. Teachers can encourage students to become self-reliant by freeing them to make reasonable guesses and to use trial and error to gain insight into a problem.

Working Backwards

Sometimes it is easier to solve a problem by working backwards rather than attacking the problem head on. Working backwards involves a change in perspective in that the new starting point was the original goal and the original starting point the new goal. Working backwards can be helpful because problems are often easier solved in one direction than another.

Working backwards has many useful applications. Suppose you are writing a position paper to your boss to convince her to accept particularly crucial idea. In thinking about how to draft the paper, you might begin by working backwards and ask yourself, "What kinds of questions would she ask me? What would be her major objections? How do I keep from offending her?" By working backwards, by starting with the goal, a more convincing paper can be written.

Finding All the Possibilities

Another important strategy for problem solving is to have a systematic way of listing all possible outcomes of some occurrence. The system must insure that all possibilities are listed and also that only those possibilities which "make sense" from the structure of the problem are listed. An example of an orderly way to list all possible ways for something to happen or all possible arrangements is show below. Thinking exercises about drawing marbles from bags are useful for developing orderly ways to exhaust all possibilities and they are generalizable to a large number of actual situations.

EXAMPLE: Suppose there are four marbles in a bag, numbered 1, 2, 3 and 4. What are all the ways to draw out the marbles if, once a marble is drawn, it is not returned to the bag? One orderly way of thinking is to actually make a list with the help of a running conversation with oneself:

"OK. Suppose I happen to take out the 1 first?" 1

"Now, I'll list all the ways if the 2 comes second. (Then later, if the 3 comes second and if the 4 comes second.) So there is 12 followed by 34 and 12 followed by 43. And there is no other way for 1 followed by 2." 1 2

1 2 3 4
1 2 4 3

"Now, what are all the ways for 1 first and 3 second? There is 13 followed by 24 and 13 followed by 42. And there is no other way for 1 first and 3 second." 1 3

1 3 2 4
1 3 4 2

"Finally, what are all the ways for 1 first and 4 second? There is 14 followed by 23 and 14 followed by 32. And there is no other way for 1 followed by 4." 1 4

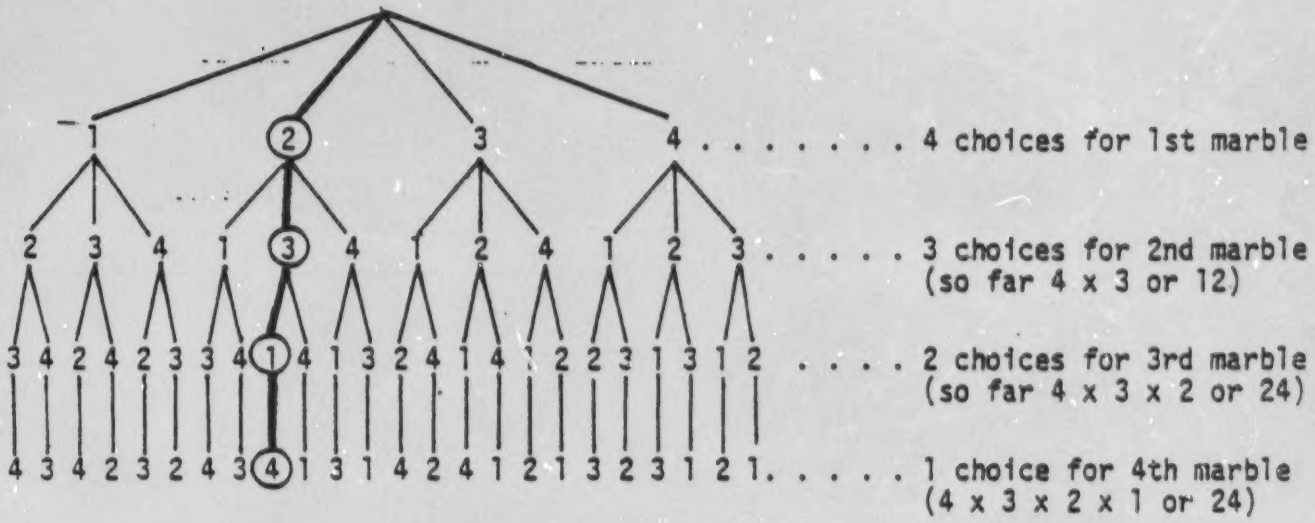
1 4 2 3
1 4 3 2

A similar conversation goes on with oneself to generate all the arrangements when 2 is drawn first, when 3 is drawn first, and when 4 is drawn first. The results:

2 1 3 4	3 1 2 4	4 1 2 3
2 1 4 3	3 1 4 2	4 1 3 2
2 3 1 4	3 2 1 4	4 2 1 3
2 3 4 1	3 2 4 1	4 2 3 1
2 4 1 3	3 4 1 2	4 3 1 2
2 4 3 1	3 4 2 1	4 3 2 1

So, there are 24 ways to draw four marbles in order if the drawn marble is replaced in the bag. Every possibility is listed and there are no more.

Another skills for finding these 24 possible ways is to draw a "tree":


4 choices for 1st marble
3 choices for 2nd marble
(so far 4 x 3 or 12)
2 choices for 3rd marble
(so far 4 x 3 x 2 or 24)
1 choice for 4th marble
(4 x 3 x 2 x 1 or 24)

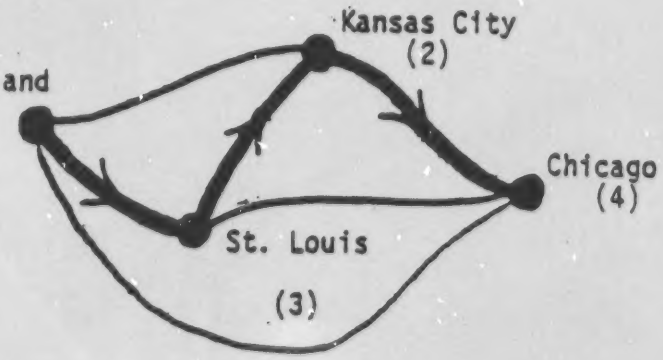
There are 24 "paths" down this "tree" and the one that is indicated above represents the combination 2 3 1 4.

The skill of drawing a tree to determine all possibilities is an important one. Suppose all the possible ways to arrange 10 digits (without replacement as in the above example) were critical information for the solution to a problem. Listing all the possibilities would be formidable and the tree would be impractical to draw. But by reducing the problem to a simpler problem (another problem solving strategy) one could realize that there is a pattern

for finding the number of combinations. The tree for the 4-digit problem makes it clear that there are 4 x 3 x 2 x 1 or 24 ways to arrange four digits. So it is logically sound to compute 10 x 9 x 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1 to find the number of ways to arrange 10 digits (without replacement).

This kind of thinking is useful problem solving skill. The 4-digit problem has the same structure as figuring out, for example:

- How many different ways can 4 colors be used to paint a car if the colors for the body, the top, and two parts of the trim are arranged differently? (24 ways)
- What is the probability of drawing the "winning number" 2 1 4 3 from a box containing four chips labelled "1", "2", "3", and "4"? (1/24 or 1 of the 24 possibilities).
- How many different routes are there which reach all of 4 cities only once and which could originate in any of the four cities? (24) One such route, (1) Cleveland to (3) St. Louis to (2) Kansas City to (4) Chicago, is shown below. The illustration shows that regardless of the city of origin, any other city can be reached next, making this situation analagous to the 4-digit problem.



(leave room

Very often, the number of ways to do something or the likelihood of an event occurring is important information for solving a problem, not only in mathematics, but also in other situations.

Time Management. Time management can influence problem solving. Poor scheduling can lead to insufficient time to work through a problem to a solution, or perhaps to never even getting to the problem. An appropriate amount of time must be allocated for reflecting on the problem, for considering different ways to approach a solution, and for reviewing and critiqueing the steps used. The pressure that can result from poor scheduling can cause subpar problem solving by limiting the amount of planning time and the time needed for patient deliberation. A student's patience and perserverance is often a key to good problem solving. A necessary condition for this is good time management skills.

We have recommended to students that they keep a chart of their activities to use as a basis for managing their time better. Time priorities often have to be set each day and a chart or list can help. Some students do not manage their time well enough to acquire an essential piece of knowledge, get to the library, or talk to someone who can help them. Allocating specific blocks of time to specific tasks according to their importance and the time they require is a useful skill. Systematic reflection on one's use of time and on how much is lost if it is used inefficiently can lead students to modify their own behavior.

Logical and Critical Reasoning

A lack of logical and critical reasoning skills hinders students' progress in becoming adept problem solvers. The more we listen to them talk aloud about their problem solving, check their papers, and observe their activities,

the more we are impressed with the extent of their deficiencies in logical and critical reasoning.

One of the major problems students have is dealing with ambiguities in the English language. For example, consider the real-life story of a famous mathematician who had to take a driving examination. He had memorized many statements from a booklet, including the following:

It is illegal to park within 15 feet of a fire hydrant.

As part of the test, he was given some "true-false" questions, one of which was:

It is illegal to part within 9 feet of a fire hydrant. False __ True __

The mathematician checked "True" on the grounds that if the statement he had memorized was true, then the question in the test was true. The examiner, however, claimed that the correct response was "False," since the statement in the booklet explicitly mentioned "15 feet" and not "9 feet."

Next consider the phrase from the song "Home on the Range":

"...and the skies are not cloudy all day."

What on earth does it mean? Does it mean that all day long there is <u>never</u> a cloud in the sky? Does it mean that the skies are not cloudy <u>all</u> day long--there is usually a moment, about 2:15 p.m. or so, when a bit of sunshine and blue sky breaks through? Just what does it mean? Does it mean that, on the average, the skies are much less cloudy than they were back East? Who knows?

As another example, consider the two statements:

a) A Swede invented dynamite.

b) A Swede is a European

The meaning of the indefinite article "A" before "Swede" in these two statements is quite different: in (a) it means <u>one</u>; in (b) it means <u>every</u>.

The phrase "...and the clouds are not cloudy all day" was, of course,

never intended to be a precise statement about anything. It was intended merely to evoke an image of the clear, bright, sunny West. But, even when one tries to be precise, the ambiguities of English can present problems for students.

As an illustration of the role of logical reasoning in problem solving, the following table was given to a class of high school seniors.

Resting Systolic Blood Pressures Found in 20 Patients

Morning Patients (Doctor I)				Afternoon Patients (Doctor II)			
Patient Number	Sex	Age	Pressure (mm Hg)	Patient Number	Sex	Age	Pressure (mm Hg)
1	F	25	120	11	F	22	122
2	M	42	150	12	F	47	151
3	F	22	120	13	M	21	118
4	F	35	135	14	F	40	133
5	F	45	145	15	F	44	141
6	F	31	125	16	F	19	126
7	F	21	120	17	F	25	120
8	F	27	130	18	M	22	128
9	F	32	130	19	F	39	133
10	F	20	120	20	F	21	123

Accompanying the table was the statement:

> If a patient had both a morning and an afternoon blood pressure reading taken, then the afternoon reading would be higher.

Students were to select one of the following as their answer:

(A) The statement is <u>supported</u> by the information given.

(B) The statement is <u>contradicted</u> by the information given.

(C) The statement is <u>neither supported nor contradicted by</u> the information given.

Every student in the class of 12 pupils marked "B" because they said that no patient had a morning and afternoon reading. This is an incorrect interpretation of the hypothetical "If...then..." statement. The correct answer is "C" since no consistent pattern exists of higher readings in the afternoon.

This same class also declared these next two open sentences to be equivalent:

(1) $x(x-3)=0$

(2) $x=0$ and $x=3$

They are not equivalent. However, the two sentences would be equivalent if the work "and" were replaced by "or".

Students need to be given more practice and guidance in dealing with the logic of problems with a particular emphasis on teachers giving them many sound and appropriate problems to work and listening to them reason aloud. We strongly recommend An Introduction to Logic by Exner and Kaufman (1978) from CEMREL, Inc., St. Louis, Missouri.

Critical reasoning is another area of student deficiencies. Students often lack skills to assess expressed ideas, beliefs and statements which one encounters daily through the media and through remarks made by people in the form of opinions, reports, rumors, etc. There is quite a well-organized body of knowledge on critical reasoning.

The process of critical inquiry is an impartial one. Judgments and evaluations are delayed until the data is in. Observations, people's opinions, collected information, etc., should all be in before decisions are made. The process is to be objective, avoiding preconceived versions of the results. It should be open enough to invite further inquiry if people are not satisfied and problems are not solved. Also, in critical inquiry people's feelings are often involved. Respect for people's personal dignity must be remembered when people are the objects of the inquiry.

Another important part of critical inquiry is evaluating the assumptions being made during the inquiry. If assumptions are not clearly in mind, then invalid conclusions can be drawn, inappropriate decisions made, or people's feelings hurt. An example from Joan Hearn's (1982) More Life Skills is:

> Willie Jones is a fifteen year old, Grade 10 student who spent Saturday night breaking windows at his high school.
>
> His mother's assumption is that his is a crazy, mixed-up kid.
>
> His father's assumption is that boys will be boys.
>
> His principal's assumption is that there are too many boys like Willie about and that the school is better off without them.
>
> The police's assumptions are that public property must be protected and wrong doers must be discouraged.

It is clear that if Willie's mother were to discuss Willie's activities with his high school principal, neither of them is going to get anywhere because they are arguing from different assumptions.

People can improve their critical reasoning skills. And it is evident from our experience that there is no substitute for practice. Students must be given good situations, problems, and simulations from which to develop and sharpen their skills. An excellent source is Joan Hearn's (1982) More Life Skills.

Gathering, Recording and Analyzing Data

The first step in the Problem Solving model is to understand the problem. When full information is presented to a student, understanding the problem involves careful reading, eliminating extraneous information, and for some problems, drawing a sketch or a diagram or organizing given data in a table. These are the usual kinds of problems students are given in school. Unfortunately, most problems encountered in one's life (at work, at home, or socially) are not so "neat." Crucial or helpful information is often missing and the problem solver must have skills not only for obtaining necessary information, but also for recognizing what information is needed. Some example of such problems follow.

- How can productivity be increased in Plant A?
- How can the absentee rate be reduced?
- What is the least expensive way to get Job X done, considering labor costs, cost of materials and employee morale?
- How do I get my car started so I can get to work on time this morning?
- What steps can I take to effect a behavior change in Person Y?
- To cut costs and maintain sales volume, where can money best be saved in the production of Product X, packaging or advertising?
- What is the best solution for a problem involving a desagreement between labor and management?
- How can the quality of on-the-job training be improved to teach skills more efficiently?
- What are the important variables for increasing morale?
- How can I plan my finances to reserve X amount of money per month for investments?

Data-gathering can occur on many levels. In some cases, understructured observation is useful. For example, simply watching a production line for an hour could help a person to generate ideas for a more structured efficiency study. Or a task-oriented

group could be observed for clues about group discord. More analytical data-gathering involes the use of checklist or coding of events or behaviors. Once data is collected, a second skills is to summarize the information in a meaningful form. If the information is quantitative, data from a checklist can be recorded in a variety of kinds of graphs, tables, or figures. Non-quantitative observations can be categorized or written up as a case study. The skill of selecting a way to represent data interacts with a third skill: analyzing observational results.

General Motors recognizes that data-gathering is often critical for problem-solving. The manual they use for training employees to conduct Employee Participation Groups includes the following data-gathering skills:

1. Making Check Lists. The following examples from the GM manual show how information can be organized about two different aspects of possible causes of a parts shortage (e.g., type of part and number of shortages by month). Direct observations are recorded as they occur.

Type Of Part	Number Of Shortages By Month												
	J	F	M	A	M	J	J	A	S	O	N	D	Total
001	✓												
002	✓✓												
003													
004													
005													
006													
Other													
Unknown													
Total													

Type Of Part	Number Of Shortages By Shift				
	1	2	3	Other	Total
001	✓				
002		✓	✓		
003					
004					
005					
006					
Other					
Unknown					

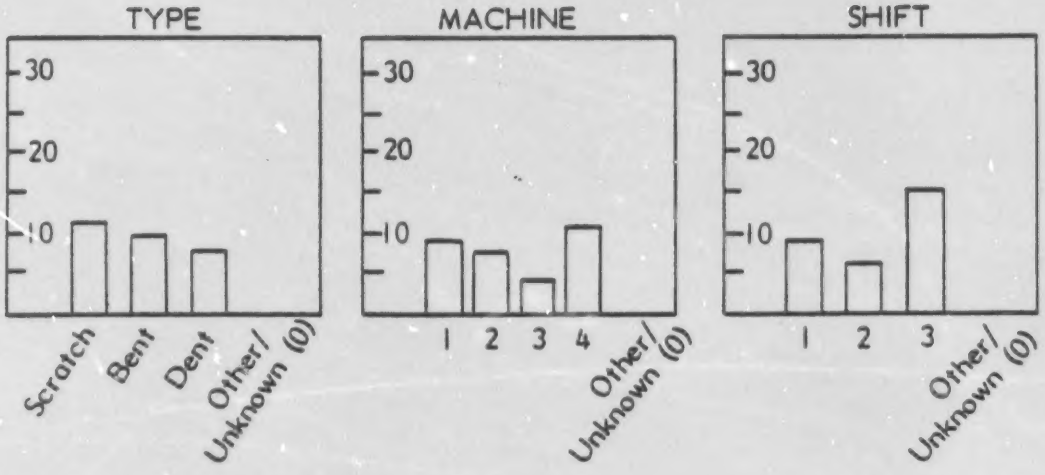
Type Of Part	Length Of Shortage				
	1 Hr.	1 Wk.	1 Mo.	Other	Total
001		✓			
002	✓		✓		
003					
004					
005					
006					
Other					
Unknown					

2. Making Charts. Information from check lists can be recorded in charts which help the problem-solver to analyze the problem to be solved.

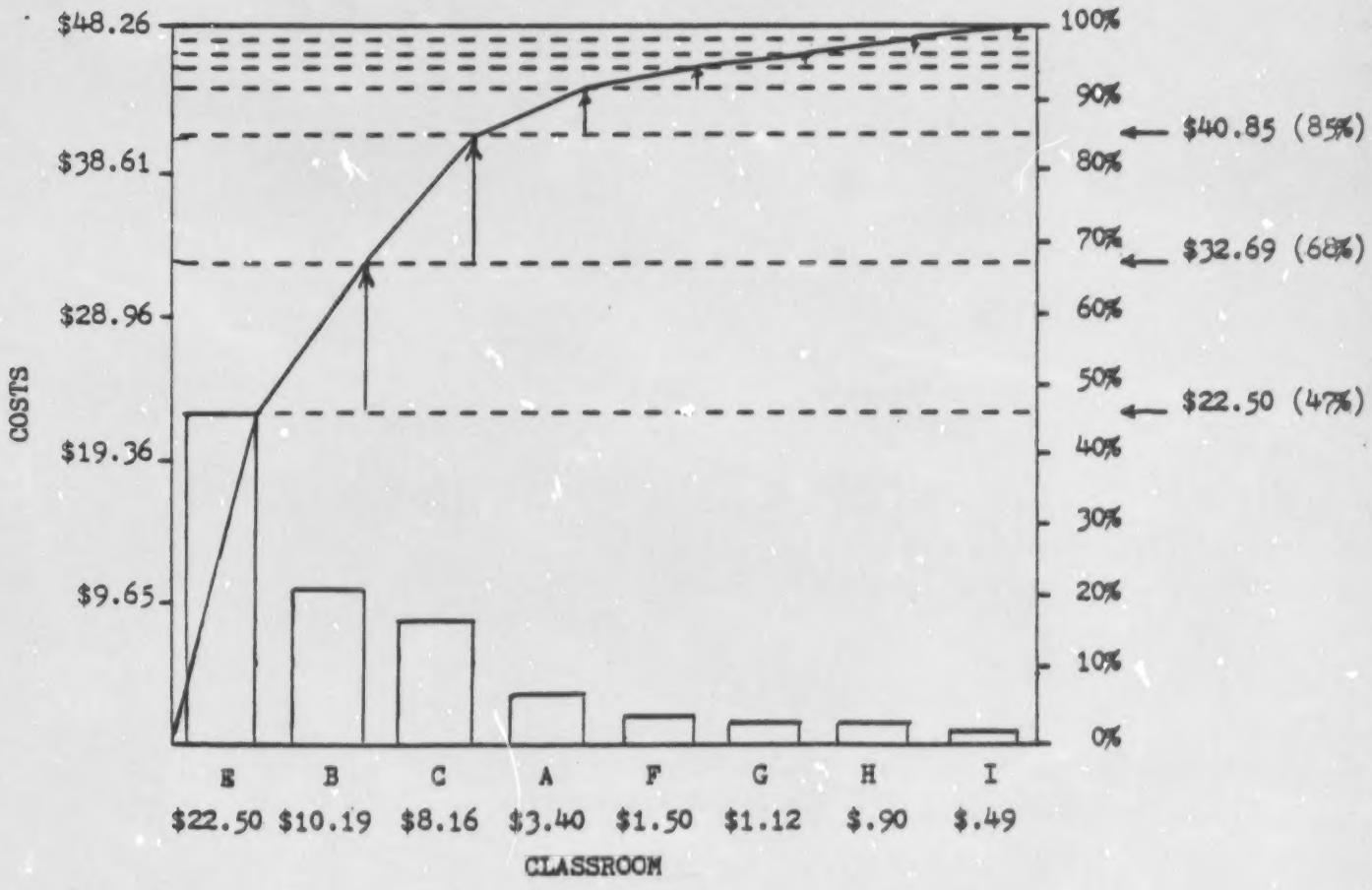
An example:

Type Of Reject	Machine				Total
	1	2	3	4	
Scratch	4	2	1	5	12
Bent	3	1	2	4	10
Dented	1	4	1	2	8
Other/Unknown	0	0	0	0	0
Total	8	7	4	11	30

A second kind of chart is a bar graph. The following graphs indicate that possible causes of rejects to consider first might be (1) something making scratches (12 of the 30 rejects); (2) involved with the 4th machine (11 of the 30 rejects); (3) on the 3rd shift (15 of the 30 rejects).



A third kind of chart is a Pareto chart. Pareto charts organize vital information and data in a cummulative way. In the following example from Lloyd and Rehg (1983), the weekly cost of supplies for eight classrooms has been converted into percentages which have been depicted in a bar graph with the percentages in descending order. The solid line illustrates cumulative percentages. In this example, the graph shows that classrooms E and B are responsible for 68 percent of the total expenditure. One option from this data is to conclude that the other classroom expenditures are "trivial" factors and attention should be focused on the costs for schools E and B.



Social and interpersonal problem solving can also require data-gathering. Much of this must be done via observation of people and their interactions. In conflicts between two people, the needs of both people must be known and good listening skills (to be outlined in a later section) can provide much of the necessary data. For example, if an employee gradually becomes less productive and less cooperative, a supervisor's listening skills might reveal problems ranging from poor health to financial problems to unsatisfactory working conditions. Such information-gathering is critical for interpersonal problem solving.

Many interpersonal problems involve needs, preferences, or values of groups of people. Useful information can be collected via interest surveys, evaluation forms, or other questionnaires. One of the most effective ways to improve the quality of training programs is to conduct frequent anonymous evaluations by participants. Tallies of responses to objective items often reveal patterns of possible causes of problems. For example, ratings for the instructor's rapport with the class might be low while ratings for instructional materials are high. Open-ended questions are extremely useful and usually give additional additional relevant information.

Objective observation of group dynamics is often the key to solving problems involving group cohesiveness and group productivity. In most groups, people assume roles (leader, follower, antagonist, peace-maker, clown, etc.). Observation of interactions among members of a group is useful information for a group facilitator.

Good and Brophy (1978) give many examples of instruments for gathering information about classroom dynamics and teacher behavior. The following form, for example, can be used to determine whether a teacher is giving appropriate feedback to students about the adequacy of their responses in discussion and recitation sessions.

TEACHER FEEDBACK WHEN STUDENT FAILS TO ANSWER CORRECTLY

DIRECTIONS: When a student is unable to answer a question or gives answers incorrectly, code as many categories as apply to the teacher's feedback responses.

BEHAVIOR CATEGORIES

1.	Criticizes	1. ____	13. ____
2.	Says "No," "That's not right," ect.		
3.	No feedback--goes on to something else	2. ____	14. ____
4.	Ambiguous--doesn't indicate whether or not answer is acceptable	3. ____	15. ____
5.	Asks a student or the class whether answer is correct	4. ____	16. ____
6.	Asks someone else to answer the question	5. ____	17. ____
7.	Repeats question to same student, prompts ("Well?" "Do you know?" etc.)	6. ____	18. ____
8.	Gives a clue or rephrases question to make it easier	7. ____	19. ____
9.	Asks same student an entirely new question	8. ____	20. ____
10.	Answers question for the student	9. ____	21. ____
11.	Answers question and also gives explanation or rationale for answer	10. ____	22. ____
12.	Gives explanation or rationale for why student's answer was not correct	11. ____	23. ____
13.	Praises student for good attempt or guess	12. ____	24. ____
14.	Other (specify)		

If instruction in problem solving is to be transferable to real-life problems, students must learn to gather relevant information and they must be armed with tools for recording and analyzing their observations.

THE FIVE STEP MODEL EXTENDED FOR PROBLEM SOLVING

The Five Step Model has been developed as an aide for students in solving problems. It is extended here to show how many useful strategies can be embedded within the model.

Extended Model

1. Understand the problem

   - o What are the essential data?
   - o Is there enough information to solve the problem?
   - o Would a figure or sketch help? Maybe introduce symbols or other variables.
   - o Separate the problem into manageable parts, if needed. Write down each part.
   - o Can the problem be restated in a different way to help understand it?

2. Brainstorm for Possible Solution Strategies

   - o Generate a lot of ideas. Don't judge them, just write them down.
   - o Has a problem like it been solved before?
   - o Would working a related problem be useful?
   - o If there were some particular additional information, would the problem be solved? Where would the information be obtained?

3. Choose a Tentative Solution Strategy

   - o Remember, the strategy may not work and the process may have to be started over.
   - o For "people" problems, consequences associated with carrying out tentative strategies must be carefully weighed.
   - o Also, if people are working out an interpersonal problem, then the tentative strategy will likely be a compromise. No one is likely to get everything they want.

4. Carry Out the Tentative Solution Strategy

   o Check each step as the plan in carried out. Check that each step is OK. Is each step correct or valid?

   o Are there probably places for errors, mistakes, or faulty reasoning? Where are they?

   o Would it be useful to have someone else go over your steps?

   o For implementing solutions to "people" problems, decide "Who does What, When." Maybe write it down.

5. Learn

   o Check the result if possible. Is the judgment sound? Does it have a reasonable chance of solving the problem?

   o What are the implications or consequences of the solution?

   o Could the problem be worked another way? Perhaps look at other people's solutions and hear what they have to say.

   o If appropriate, evaluate the effectiveness of the solution.

   o Have enough problems like this one been worked to begin to generalize to a plan for solving similar problems?

   o Does this solved problem open up new relationships that hadn't been thought of before? Think about it!

   o What are your strengths as a problem solver? Your weaknesses?

   o Are you getting involved in solving problems? Are you doing the work or is someone else? Your involvement is essential.

Higher Order Problem Solving Skills

Since its inception in 1969, the National Assessment of Educational Progress (NAEP) has surveyed the knowledge, skills, and attitudes of over one million students. The Education Commission of States, which collects this data, reported that "today's minimum skills are demonstrated successfully by a majority of students. Higher order skills, however, are achieved only by a minority of 17-year-olds, and this proportion declined over the last decade. If this trend continues, as many as two million students may graduate in 1990 without the skills necessary for employment in tomorrow's marketplace" (Education Commission of the States, 1982, p. 2). They further noted that:

> The "basics" of tomorrow are the skills considered to be of a higher level today. These skills include:
>
> - o Evaluation and analysis skills
> - o Critical thinking
> - o Problem-solving strategies (including mathematical problem-solving)
> - o Organization and reference skills
> - o Synthesis
> - o Application
> - o Creativity
> - o Decision-making given complete information
> - o Communications skills through a variety of modes (p. 6)

A survey of 123 school systems (Henry & Raymond, 1982) found that the basic skill of "reasoning" had the smallest percentage of school systems evaluating students as having superior preparation. Sixteen percent of the schools acknowledged that "the majority of work force-bound students were inadequately prepared to reason through complex problems and decisions" (p. 21).

Archie E. Lapointe (1984) Executive Director of the Center for the Assessment of Education Progress, drew the following conclusion from NAEP findings.

> Closer examination of the data reveals that poorly developed problem solving skills hinder students' performance in mathematics. Indeed, weaknesses exist in the so-called higher-order skills in general. Most students do well with literal comprehension but lack the skills of inference,

> analysis, and interpretation. Today's definition of functional literacy calls for these higher-order skills more than ever before, even as students' mastery of them is seemingly on the decline. Clearly, a renewed focus on these skills is needed (p. 666).

As students attempt to solve more and more complex problems, the need for them to acquire higher-order problem solving skills increases. For General Motors, some of these skills are problem analysis, decision-making, and planning. Some higher-order skills listed by Piaget are hypothetical thinking, observing and discovering patterns, establishing relationships, making generalizations, and sophistication with combinatorial and probabilistic thinking. Bloom's (1956) hierarchy of cognitive skills begins with knowledge of facts and extends to higher-order skills.

Level 1: Knowledge. The ability to recall specific facts, methods, or procedures: terminology, facts, rules, trends, classification schemes, criteria, methodology, principles, generalizations, theories, structures. This level involves little more than retrieving stored information.

Level 2: Comprehension. The ability to make use of what is being communicated: to translate or put information in another form (restate an idea, interpret a diagram, summarize, draw a picture); to interpret or reorder ideas and comprehend inter-relationships; to extrapolate or go beyond the given data (drawing conclusions, theorizing, predicting). This level involves understanding ideas.

Level 3: Application. The ability to apply knowledge and principles to actual situations: generalizing to another situation. This level involves putting into action knowledge which from Level 2 has been understood.

Level 4: Analysis. The ability to classify or break material down into its components, to understand the relationships between the components, and to recognize the principle that organizes the structure or the system: to compare and contrast, to distinguish between fact and opinion, to recognize

extraneous information, to recognize unstated assumptions, to compare theories. This level involves a kind of logical thinking similar to Piaget's formal operations.

Level 5: Synthesis. The ability to bring together ideas and knowledge from many sources to form new ideas, methods, or procedures: unique communication, a plan, a set of operations, a strategy. This level involves creative or original thinking.

Level 6: Evaluation. The ability to make quantitative and qualitative judgments: to weigh, to examine, to analyze, to use criteria, to recognize the best of several reasonably good answers or solutions. This level requires the abilities of the first five levels and is crucial for substantive problem solving.

Although Bloom et. al. prepared their widely accepted taxonomy in 1956 as a guide for developing and evaluating educational objectives, actual classroom instruction has generally focused on Level 1 and Level 2 objectives. Bloom (1984) observed:

> . . . teachers in the United States typically make use of textbooks that rarely pose real problems. These textbooks emphasize specific content to be remembered and give students little opportunity to discover underlying concepts and principles and even less opportunity to attack real problems in the environments in which they live. The teacher-made tests (and standardized tests) are largely tests of remembered information. After the sale of over one million copies of The Taxonomy of Educational Objectives--Cognitive Domain (1956) and over a quarter of a century of the use of this domain in preservice and in-service teacher training, it is estimated that over 90% of test questions that U.S. public school students are now expected to answer deal with little more than information. Our instructional material, our classroom teaching methods, and our testing methods rarely rise above the lowest category of the Taxonomy--knowledge (p. 13).

There is no better context within which to develop higher-order skills than in the context of problem solving. A bonus is that the cognitive levels of knowledge and understanding can also be developed via problem solving. The

National Council of Teachers of Mathematics in its Agenda for Action--Recommendations for the 80's (1980) had as its number one recommendation that mathematical content for K-12 be taught primarily in a problem-solving context.

Simulations

In simulations, students are actively involved. The student assumes an active role as a problem solver and often controls decisions and consequences that are a part of most problem solving situations. For example, in the simulation Life-Career (published by Western Publishing Co.), students must make decisions and solve problems for a fictitious person as the person deals with work, marriage, and education. Players plan time and activities relative to school, studying, job, leisure time, and family. The game generates a universe of simulated experience that students can compare with the real world; that is, they can compare the experiences in the game to what they believe true about their own world. Sarane Boocock (1968) found that the Life Career simulation increased students' facutal knowledge about careers; established new relationships for students on how jobs, school, and family can be very interdependent; helped students learn that there is a causal relationship between their behavior and the outcome of events; and increased student confidence in their decision making and problem solving abilities.

The World Future Society published a directory of information resources which includes descriptions and references for 45 simulation games (Cornish, 1979, pp. 627-638). Some other resources:

- Simulation Games for the Social Studies Classroom by William A. Nesbitt (1971), Foreign Policy Association, Glenview, IL.
- Construction and Use of Written Simulations by Christine McGuire, Lawrence Solomon, and Philip Bashook (1976), The Psychological Corporation.
- Simulation Games in Learning by Sarane Boocock and E. O. Schild (1968), Sage Publications, Beverly Hills, CA.

Good simulations require most of the essential moves of successful problem solvers: gathering data, selecting alternatives, conducting analyses, synthesizing, generalizing, making decisions, planning, and taking action. According to William A. Nesbitt (1971), simulations teach students to think critically, examine alternative strategies, and to critique their own decisions and behaviors. Simulations provide an opportunity for students to solve substantive problems and to gain confidence in their abilities to tackle problems, wrestle with them, and by progressing a bit at a time, eventually solve them.

Interpersonal Skills for Being Effective With Individuals and In Groups

Interpersonal skills are critical for problem solving, and they have been identified as highly desirable by employers. A very recent study, Perspectives on Vocational Education (Chicago United, 1984), found that 94% of 995 employers cited the ability to work with others as the interpersonal skill they most wanted in their workers. One of the conclusions from a survey of 593 secondary vocational training teachers in 32 vocational training program areas (Greenan, 1983) was that "all interpersonal relations skills are very important for success and highly generalizable across all program areas and programs" (p.57).

Considering the importance placed on interpersonal skills by representatives of business and industry and by vocational educators, they should be part of a pretechnical curriculum. The following outline gives a listing of specific skills which are applicable in most interpersonal settings -- at home, at work, and particularly in task-oriented problem solving sessions.

Summary of Interpersonal Skills

I. Awareness of self and others
   - A. Values
   - B. Needs
   - C. Feelings

II. Recognizing problem ownership (Who is upset?)
   - A. Identifying self as being upset
   - B. Identifying other person as being upset

III. Selecting appropriate skills according to problem ownership
   - A. Assertive statements when problem owned by self
   - B. Listening skills when problem owned by other person

IV. Recognizing Roadblocks to Communication when someone owns a problem
   - A. Directive Responses
     1. Ordering, commanding, directing
     2. Warning, threatening
   - B. Solution Responses (advising, offering solutions or suggestions)
   - C. Persuasive Responses
     1. Moralizing, preaching, giving "shoulds and oughts"
     2. Teaching, lecturing, giving logical arguments
     3. Reassuring, sympathizing, consoling, supporting

D. Evaluative Responses

1. Judging, criticizing, disagreeing, blaming

2. Name-calling, stereotyping, labeling, ridiculing

3. Praising, agreeing, giving positive evaluations

4. Interpreting, analyzing, diagnosing

E. Avoidance Responses

1. Withdrawing, distracting, being sarcastic, humoring, diverting

2. Emphasizing one's own needs

F. Questioning responses (Probing, interrogating, cross-examining

G. Interrupting

V. Avoiding Roadblocks to Communication

VI. Listening

A. Encouraging the other person to talk

1. Silence

2. Nonverbal encouragement

3. Verbal encouragement

B. Responding by reflecting meaning

1. Paraphrasing

2. Clarifying, confirming

C. Responding by reflecting meaning and feelings -- Active Listening

D. Applying Active Listening

1. Dealing with anger

2. Facilitating problem solving

3. Support and rapport

VII. Assertive statements

A. Distinguishing between aggressive and assertive statements

B. Giving I-Messages

Problem Solving in Groups

Problem solving in groups is now emerging as an important part of the work world for all levels of employees, not just managers (Pratzner & Russell, 1984). Many companies are involving workers in diagnosing problems and implementing effective solutions. These organizations have implemented programs called "Quality Circles Programs," of which one important element is the Quality Control Circle. Very briefly, Quality Control Circles have these things in common. Size: preferably five to ten members. Volunteerism: freedom of choice to join. Meetings: one hour weekly, with exceptions. Skills: brainstorming, cause and effect analysis, data collection, effective planning.

Japanese industrialists have been using Quality Control Circles since 1960. As many as 11 million workers are involved in Quality Circle movements throughout Japan, and idustries in all of the world's industrialized countries have shown interest in implementing the process. The Lockheed Company's Missile and Space Division was the first United States organization to put the concept into action in 1974 and a $500,000 investment in the program resulted in an estimated savings of $3 million (Lloyd & Rehg, 1983).

The National Center for Research in Vocational Education listed organizations in the public sector which have implemented employee participation groups (Lloyd & Rehg, 1983). Among these are the U.S. Air Force, the U.S. Army, the U.S. Navy, and the Federal Aviation Administration. Also listed were 162 organizations in the private sector. Among these are such major companies as Bendix Corporation, Firestone, G. E. Major Appliances, General Foods, General Motors, Hewlett Packard, Hughes Aircraft, J. C. Penney, McGraw-Edison, Polaroid, 3M, Union Carbide, Uriroyal, and Westinghouse.

Not only are Quality Control Circles advantageous for productivity in business and industry, they are very effective for problem solving in any organization. Lloyd and Rehg (1983) gave an example of effective use of Quality Control Circles by school districts.

> . . . a midwestern schhol district has used the QC process to solve problems that results from declining enrollments and escalating costs (Rehg, 1982). Ten quality circles made up of administrators, faculty, staff, and citizens met to develop solutions which were then compiled and distributed to the ten groups. Consensus was reached, and the proposed solution was then presented to the public for review. The school board adopted the solution essentially as proposed by the quality circles. No complaints were received nor were any grievances filed despite the facts that some teachers were reassigned and some terminated, and that some schools were closed. In contrast, the school board, in an adjoining district facing a similar problem, made a unilateral decision to close certain schools. In response, a citizen's group filed a lawsuit in an attempt to block the closing.

Pratzner and Russell (1984) have delineated the skills, knowledge, and abilities needed for high-involvement participative work setting (pp. 12-13). Under the skill are Group Problem Solving they list eight sub-categories: Interpersonal Skills, Group Process Skills, Problem-Solving Skills, Decision Making, Planning, Communication and Thinking/Reasoning. The specific skills for two of these categories are given below.

Interpersonal Skills	Communication
o Self-directed	o With individuals
o Flexible	o With groups
o Assertive	o Presentation skills
o Open	o Verbal skills
o Curious to learn	o Writing skills
o Able to share/teach	o Listening skills
o Responsive	
o Understanding of behavior	

The General Motors Employee Participation Groups Manual (1980) is used to train employees to be effective group members. Many of the skills the employees learn are interpersonal skills. Some examples:

Involving Others. You may notice some people getting quiet during a meeting. They may have information or ideas but may be reluctant to break into the discussion. You can "invite" them in. Example: "John, we haven't heard from you yet. What do you think?"

Give Credit--Avoid "Put-Downs". If you borrow another's idea or add to it, give them credit for the basic idea. If you don't like another's idea, avoid criticizing the person. Example: "Mary's idea of using the scrap is a possibility. I like it better than not using the scrap." (Not using the scrap was Paul's idea.)

It is not sufficient for successful group problem solving for a person to be adept at problem solving strategies without also having good interpersonal skills. Unlike individual problem solving, group solution strategies are usually arrived at through processes which require listening, empathy, cooperation, and concern for everyone's needs.

The Five-Step Model is highly adaptable to group problem solving, whether mutual problems exist for only two individuals or a group. Some problems center around Conflict of Needs. That is, the needs of one or more persons are not being met, and a change in the behavior of the other person or persons is necessary to solve the problem. In such situations, the specific interpersonal skills described earlier are necessary, particularly at the first step, as shown below.

Five Step Model for Solving Problems Resulting from a Conflict of Needs

1. Understand the Problem

   - o One person initiates the process by giving an I-message.
   - o Often, the other persons will be defensive or will unveil their own related problems, so the first person must reflect meaning or actively listen in order for the real problem(s) to be identified. Avoiding roadblocks is critical at this point, particularly if the sharing becomes emotional.
   - o Once the problem is clarified, it should be summarized to be certain that there is agreement on what the problem is.

2. Brainstorm for Possible Solutions

- o Suggestions are not to be evaluated, and a skillful person encourages others to contribute ideas.
- o Self-knowledge is important for resisting tendencies to interrupt, to put other people's ideas down, or not to be open to new ideas.

3. Choose a Tentative Solution

- o Although compromise is sometimes necessary at this stage, the needs of both or all people must be met as best as possible. Assertive statements are important if one feels that a solution is not good for all the people involved, particularly for oneself.

4. Carry Out the Tentative Strategy

- o It is important to decide "Who, does What, When."
- o A very specific time should be sent for evaluting the solution, which should be considered a trial solution, perhaps the first of several attempts to meet everyone's needs.

5. Learn

- o As new procedures, routine, or behaviors are attempted, look for opportunities to increase self-knowledge. If the solution is not working, this is the time to look more closely at your real needs. Perhaps the problem, as you saw it, was not the real problem for you. Maybe you need to change what you are doing. Maybe the environment needs to be changed.
- o Evaluate the effectiveness of the solution. The process might need to be repeated, from steps 1 through 5.

Thomas Gordon (1974) calls this process the "No Lose" problem solving method. In most interpersonal problem solving one person "wins" and the other "loses". Examples are: authoritarian classrooms where teachers "win" and students "lose" or permissive classrooms where students "win" and teachers "lose." Analagous situations occur in business and industry when management and labor become involved in power struggles. The objective of the Five Step Model is to resolve conflicts or to solve problems so that everyone gets some of their needs met.

This kind of process is used in business and industry when Quality Control Circles engage in group problem solving and the results have been impressive. Lloyd and Rehg (1983) gave examples of the outcomes of some of these group efforts.

- A Quality Control committee suggested a procedure which was initiated by the Purchasing Department at Westinghouse Electronics Systems Center in Baltimore, Maryland. By returning overshipments to vendors at their own expense, an estimated $636,000 was saved.
- Management of a General Motors plant in Tarrytown, New York was considering closing the plant down because of high absenteeism and poor product quality. The number of outstanding employee grievances against management totalled two thousand. Since Quality Circles began to hold meetings to discuss complaints and ideas for boosting efficiency, the number of outstanding grievances has dropped to thirty, and absenteeism has been reduced to 2.5 percent.
- At the Lockheed Company, a Quality Circle developed a method to mold a plastic part assembly in two instead of five steps. The redesigned assembly is lighter and stronger than its predecessor, and has resulted in an estimated savings of $160,000 over the life of the contract. Since 1974, Lockheed's savings from its Quality Control program are estimated at almost $3 million, six times the cost of operating the program.

The Need for Interpersonal Skills for Negotiating

Whether between individuals or in groups, interpersonal skills are central to successful negotiation as described by Fisher and Ury in their 1983 best-seller, Getting to Yes: Negotiating Agreement Without Giving In. Negotiations occur in everyday life, as when a person returns a defective product and needs a settlement or when price differences must be resolved. In more formal negotiating processes, individuals represent constituencies and negotiating sessions are sometimes hardhitting encounters, even to the point of using "dirty tricks." Fisher and Ury, however, advocate an approach that consists of skillful interpersonal interactions combined with assertive skills. Some of the skills they mention are awareness of one's fellings, active listening, and I-messages.

". . . human beings . . . are creatures of strong emotions who often have radically different perceptions and have difficulty communicating clearly. Emotions typically become entangled with the objective merits of the problem . . . Figuratively if not literally, the participants should come to see themselves as working side by side, attacking the problem, not each other (p.11)."

Conclusion

It is clear that the American workplace is placing increasing importance on employee problem solving and that interpersonal skills are needed to be effective in problem solving groups. In addition, most citizens are involved in several groups in their daily lives-- in classes they take, in PTA's, in social groups, in church groups-- and the quality of their participation would be enhanced by being more skilled interpersonally. That is sufficient evidence to consider interpersonal skills "basic" and to seriously consider where and how they should be taught in the pre-technical curriculum.

There is a need for a formal curriculum for problem solving skills. Skills must be studied, analyzed, and practiced. At the same time, teachers should acquire these skills themselves so that they will be effective models for students. Teachers must be prepared to facilitate problem solving whenever the need arises. These are the learning experiences which students will remember above all others. Active involvement in actual problem solving is invaluable, and this should occur at <u>all</u> grade levels.

Implementation

The design for implementation of a pretechnical curriculum presented in this section synthesizes ideas of Dyrenfurth (1984) on technological literacy of Levin and Rumberger (1983) on recurrent education, of Silberman (1983) on the goals of vocational education, and Pratzner's (1984) work on socio-technical literacy. The design is based on the following assumptions:

- Employees will work in environments influenced by change and technological innovations.
- The structure of the labor market will require differing degrees of training. Periodic retraining will be a significant part of the work experience, regardless of an individual's position within the structure.
- Education must give individuals the skills needed at entry level positions and for undertaking education and training as needed to progress occupationally.
- Employees will have increased opportunities to work in high-involvement industries, which will increase their opportunities to participate in problem solving and in group consensus decision making.

The responsibility for providing a pretechnical as well as a technical education is the shared responsibility of both subject matter and vocational education teachers. Vocational educators are primarily responsible for cooperating with subject matter teachers to insure that appropriate and up-to-date applications are being taught. They are also primarily responsible for teaching entry level job skills and for preparing students to deal with their work lives.

The responsibilities for vocational educators are further extended by the fact that individuals enter the labor force at different times in the educational sequence. For instance, they must provide for drop-outs who have not achieved

a minimal level of technological literacy and for enrolled students who are seeking first jobs with minimal level job skills.

The skill to be implemented are depicted in Figure 1 which displays who does what when.

Figure 1

Implementation Structure

Generalizable Skills	Transition Skills	Problem Solving Skills
Reasoning	Change in Environment	Cooperative Group Skills
Communication	Change in Relationships	Interpersonal Skills
Mathematical	Change in Self	Information Related Skills
Interpersonal	Stress, Loss, Grief	Task Related Skills
Attitudinal	Decision Making	Understanding Human Behavior
Technological		

PRETECHNICAL EDUCATION (7-12)		TECHNICAL EDUCATION
EDUCATIONAL LEVEL: 7-10 CONTENT: Generalizable skills Transition Skills Problem Solving Skills INSTRUCTIONAL RESPONSIBILITY: Cooperative teams of vocational teachers and subject matter teachers	EDUCATIONAL LEVEL: 11-12 CONTENT: Generalizable Skills Tranisition Skills Problem Solving Skills Entry Level Job Skills High Tech Skills (The emphasis will be on simulations) INSTRUCTIONAL RESPONSIBILITY: Vocational Educators	EDUCATIONAL LEVEL: 13 and beyond CONTENT: Job skills related to specific occupations. INSTRUCTIONAL RESPONSIBILITY: Vocational educato Industrial trainer Apprenticeship Programs

ENTRY LEVEL JOBS, TRAINING PROGRAMS, AND RETRAINING PROGRAMS

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Generalizable Skills refer to the skills which are actively used in work performance, which are transferable across jobs and which are instrumental to success on the job and in the classroom. Typically, Generalizable Skills are associated with the traditional subject matter classes such as mathematics, reading, English, social studies and science and include reasoning, communication (written and oral), interpersonal and attitude skill attainment. These well formed bodies of knowledge are the "basics" of grades 7-12. It is still appropriate and necessary that subject matter teachers continue teaching these subjects, specifically, there is still a need for teachers who teach English, math, science, etc.; however, this is not sufficient.

Researchers (Brammer & Albrego, 1980; Adler, 1982; Daniels & Karmos, 1983; DeBevoise, W., 1982; Givvons, 1984; Goodlad, 1983; Gisi, 1982; Timpane, 1982; Pratzner & Ashley, 1984) have suggested that there exists other skills to be learned which intersect with every subject matter field and vocational education class; these skills have been identified as Transition Skills and Problem Solving Skills. Transition Skills have never been taught directly and Problem Solving Skills have only been taught within specific content areas: math, science, etc.

In order that Problem Solving Skills become more integrated throughout the entire curricula content, it must take on a more generic character; that is, a general modle is needed which could serve two purposes: (1) Problem solving would be taught in all classes, and (2) by using the same model across all subjects a unified approach to problem solving across context and situation would result. As can be seen in Figure 1, it is proposed that all grade 7-12 teachers would be trained to implement this model which would not only include subject specific problems to be solved, but also group and interpersonal problem solving, and transition training.

As students in grade 7-12 go through a myriad of transitions both educationally and developmentally which affect many areas of their lives and which continue across their lifespans, it is suggested that in order to maximize their ability to adapt to these transitions, that they be directly taught skills which would ensure this outcome. Specific training is needed to assist individuals as they pass through transitions. All teachers in grades 7-12 would be trained to teach Transition Skills.

The responsibility of vocational educators in grades 7-12 is central to the implementation of Problem Solving and Transition Skills in that they act as liaisons between the work world and subject matter teachers to strengthen and increase the applicability of problem solving and the reality of transitions that will be confronted during work life. In grades 11 on, vocational educators have the additional responsibility of passing on the skills of getting and holding a job and of assisting students in choosing high tech or other specific skill training. Each of these skills would use the Problem Solving and Transition Skills, emphasizing hands on applications and simulations.

Figure 2 shows a simplified breakdown of reponsibility for instruction.

Figure 2

Grades 7-12	GENERALIZABLE SKILLS	----	Taught by Subject Matter Teachers
Grades 7-12	Problem Solving and Transition Skills	----	Cooperatively taught by vocational education teachers and subject matter teacners. Both would be trained to teach them.
Grades 11-12	First Job Skills High Tech Skills Simulations	----	Vocational education teachers would be trained to teach simulations.

Strategy for Vocational Education

The most important strategy and format for teaching problem solving and transition skills within vocational education is through simulations. Good simulations require utilization of the skills needed to successfully solve problems or manage transitions, and provide an opportunity for students to gain experience and confidence in their ability to deal with issues they may actually confront in their lives and work spaces.

Vocational educators could develop simulations which reflect actual work related problems and transitions such as: problems from quality work groups, worker-supervisor conflicts; transitions caused by lost jobs, being unemployed, being transferred or retrained, by losing friends, being divorced, or being promoted. Other simulations could cover automotive work, air-conditioning, metal work, agriculture, etc. These simulations could involve many subject matter areas (reading, comprehension, understanding graphs, utilizing technical information) and could substantively involve Generalizable Skills. Simulations could provide a rich domain for students to continue to develop and utilize their skills for analyzing and synthesizing information, and then to generalize to conclusions and evaluations. Vocational educators could make school come "alive" for students by simulating problems and transitions that are occurring in their lives, and students could use problem solving and transition skills to manage the simulation. This would enable students to gain confidence in their abilities to manage critical problems and transitions in their personal and work lives.

The World Future Society published a directory of information resources which includes descriptions and references for 45 simulation games (Cornish, 1979, pp. 627-638). Some other resources are:

Simulation Games for the Social Studies Classroom by William A. Nesbitt (1971), Foreign Policy Association, Glenview, IL.

Construction and Use of Written Simulations by Christine McGuire, Lawrence

Solomon, and Philip Bashook (1976), The Psychological Corporation.

Simulation Games in Learning by Sarane Boocock and E.O. Schild (1968), Sage Publications, Beverly Hills, CA.

Examples of simulations using Transition Skills and Problems Solving Skills are given below.

Simulation for Transition Skills

An example of simulations already in existence is the simulation Life-Career (published by Western Publishing Co.). Students make decisions and solve problems for a fictitious person as the person deals with work, marriage, and education. Players plan time and activities relative to school, studying, job, leisure time, and family. The game generates a universe of simulated experiences that students can compare with the real world; that is, they can compare the experiences in the game to what they believe true about their own world. Sarane Boocock (1968) found that Life Career simulation increased students' factual knowledge about careers; established for students that there is a causal relationship between their behavior and the outcome of events; and increased student confidence in their decision making and problem solving abilities.

Simulation for Problem Solving Skills (Taken from a GM Training Manual)

Your company has just obtained a one year contract for delivering six truckloads of hazardous materials a month. All six trucks are enroute, and this is the first time any one of you has driven this busy road. All trucks are identical though they are loaded differently. You will make 11 more deliveries this year.

The second truck is immediately behind the first truck, which is pulling a forklift. Four other trucks are about 15 minutes behind on the same road. The first truck went under a cement underpass with no problem, but the second truck got stuck. Comparing the shipping documents you realize the first truck is carrying 400 containers weighing 50 pounds each. The cargo is on pallets. There is an open truck service station ahead. It has a full equipped wrecker for servicing trucks on the highway.

All the trucks must arrive at the destination 20 miles ahead within one hour or your company will have to pay a penalty. There is an alternate route behind you but it is 10 miles longer with equally heavy traffic. You are members of the crew driving the stuck truck. What will you do?

Transition Model:

For vocational educators to teach problem solving and the handling of transitions through simulations, models for them need to be taught to teachers. A transition model is needed which (a) clarifies transitions, (b) accounts for the developmental issues students experience, and (c) which can be integrated into existing educational programs. Such a model is presented below.

The model is versatile. It is applicable to almost any kind of transition. The model may be used by students contemplating career or college choices, experiencing the loss of a friendship, or dealing with the loss of a parent through death or divorce. Existing programs may be integrated into the model. Some present programs are:

1. Danish and D'Augelli (1980) have developed a comprehensive approach to teaching coping skills for preventing crisis and stress. The program teaches life development skills necessary for dealing with anticipated transitions. It also deals with ways of managing crises or unplanned events and stresses communication and helping skills.
2. Brammer and Abrego (1981) use problem-solving strategies as skills for coping with and responding to transitions.
3. Meichenbaum (1977) presents guidelines for training people to cope with stress. The training model emphasizes cognitive skills and recognizes individual and cultural differences.
4. Fuchs' and Rehm's (1977) program trains people to manage feelings and emotions in dealing with transitions.

Two references (Schlossberg, 1984; Abrego & Brammer, 1979) are useful for high school teachers. Both give excellent guidelines for helping students handle transitions. Educating students to deal with life transitions should be an important part of the high school curriculum. Some guidelines are: 1) students should become aware that life transitions are natural and inevitable and that they already have personal resources for dealing with them. 2) Students should first examine and analyze transitions they are already experiencing. They should become aware of their values, interpersonal skills, competencies, and other personal resources which strengthen their ability to cope with change. 3) Students should perceive instruction as relevant to their present lives so that a meaningful extension can be made to typical anticipated and unanticipated transitions later in life. 4) Students should

become aware of future anticipated transitions such as graduation, leaving home, etc: and future unanticipated transitions such as not being accepted for college, losing a job, the death of a spouse, etc. 5) Throughout the study of transitions, the Model for Handling Transitions should be applied and it should be viewed as a problem solving strategy.

With change and transition as the rule rather than the exception it becomes evident that one of the more pressing concerns before educators today is the empowerment of students to identify, adapt, and manage transitions which occur developmentally, socially, and occupationally in their life courses. Changing times will bring more self-responsibility and more self-help. Maurice Gibbons (1984) noted that ". . .institutional care and support services are diminishing, and people can expect to take more responsibility for themselves throughout their lifetimes. Self-help is replacing institutional help (p. 593)." The management of change and transition must become a part of the learning life of the individual. This model for educating for transition is a beginning.

Problem Solving Model

In addition to a model for teaching about transitions, one is also needed for problem solving. For students to hold jobs, be retrained, and in general to adapt to a constantly accelerating rate of change in their lives, they will need strategies for how to attack and solve problems. Possession of at least one general model for solving problems is one essential strategy. There are many different models, but the one we have developed is given below.

Model for Problem Solving

I. UNDERSTAND THE PROBLEM

- ° What are the essential data?
- ° Is there enough information to solve the problem?
- ° Would a figure or sketch help? Maybe introduce symbols or other variables.
- ° Separate the problem into manageable parts, if needed. Write down each part.
- ° Can the problem be restated in a different way to help understand it?

II. BRAINSTORM FOR POSSIBLE SOLUTION STRATEGIES

- ° Generate a lot of ideas. Don't judge them, just write them down.
- ° Has a problem like it been solved before?
- ° Would working a related problem be useful?
- ° If there were some particular additional information, could the problem be solved? Where could the information be obtained?

III. CHOOSE A TENTATIVE SOLUTION STRATEGY

- ° Remember, the strategy may not work and the process may have to be started ove
- ° For "people" problems, consequences associated with carrying out tentative strategies must be carefully weighed.
- ° Also, if people are working out an interpersonal problem, then the tentative strategy will likely be a compromise. No one is likely to get everything they want.

IV. CARRY OUT THE TENTATIVE SOLUTION STRATEGY

- ° Check each step as the plan is carried out. Check that each step is OK Is each step correct or valid?
- ° Are there places for errors, mistakes, or faulty reasoning? Where are they?
- ° Would it be useful to have someone else go over your steps?
- ° For implementing solutions to "people" problems, decide "Who does What, When." Maybe write it down.

V. LEARN

- Check the result if possible. Is the judgement sound? Does it have a reasonable chance of solving the problem?
- What are the implications or consequences of the solution?
- Could the problem be worked another way? Perhaps look at other people's solutions and hear what they have to say.
- If appropriate, evaluate the effectiveness of the solution.
- Have enough problems like this one been worked to begin to generalize to a plan for solving similar problems?
- Does this solved problem open up new relationships that hadn't been thought of before? Think about it!

At the beginning, we have our students follow the Five Step Model, step by step. Later on they are encouraged to freely use their own creativity and intuition to solve problems since no single model is directly applicable to all problems.

Commercial programs for teaching problem solving exist. The June 1983 issues of the Kappan listed more than 30 programs, video-taped presentations, computer-assisted instruction, instructional programs for teachers, and materials for student use. Other excellent sources are:

- The Edward de Bono School of Thinking, P. O. Box 711, Larchmont, NY 10538
- Institute for the Advancement of Philosophy for Children, Montclair State College, Upper Montclair, NJ 07043
- Problem Solving and Comprehension by Arthur Whimbey and Jack Lochhead, The Franklin Institute Press, Philadelphia, 1979.
- More Life Skills, by Joan Hearn, Advanced Development Division, Employment and Immigration, Ottawa, Canada K1A 0J9, 1982.

° Problem Solving in School Mathematics, 1980 Yearbook, National Council of Teachers of Mathematics, Reston, Virginia.

° Instrumental Enrichment, by Reuven Feurstein, University Park Press, Baltimore, MD., 1980.

° The New MCAT Student Manual (Quantitative Skills) from the Association of American Medical Colleges, Washington, D.C., 1984.

° Medical College Admission Test (Quantitative Skills) by Morris Bramson and Lawrence Solomon, Arco Publishing, Inc., NY, 1982.

° A Complete Preparation for the New MCAT, Vol. II (Quantitative Skills) by Beryl Brain, Drew Love, and Philip Kelleher, Health Professional Education Service, Inc., Bethesda, Maryland, 1981.

Problem solving is a difficult subject to teach. But there are some essential guidelines: (1) students must be given substantive problems to solve and actively pursue their solutions. People learn by doing and their "doing" must have substance. There is no merit in teachers being superb at teaching trivia. (2) Students are to be armed with models and strategies for solving problems. Breaking problems into simple parts, making sketches, reading carefully, etc. are all necessary strategies for good problem solving. (3) Knowledge in specific content areas is necessary for solving problems in that area. One can't solve many problems in mathematics if one doesn't know much math. The best problem solvers have a very broad base of specific and general knowledge. (4) Some problems are more appropriately solved in a group setting and others in an individual setting. The group setting needs to be used more so students can better learn the give and take of cooperation that is now so vital to business and industry. (5) Students need to become more self-reflective of themselves as problem solvers. "What kinds of problems do I have difficulty with?" "What are my strengths, weaknesses?" "Where do I

need to improve?" "What can I learn from that mistake? "How do I learn best--hearing, seeing, touching, imagining?" "Where do I go for help?" Students can always become better problem solvers, and educators can always improve materials and instruction for helping it happen.

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Executive Summary

More than a decade ago Alfred Toffler (1970) predicted that most people would be ill prepared to cope with the changes that would occur in their life times. Today, few people would disagree with Toffler's predictions. Rapid technological advances have not only transformed present worklife, they have drastically altered the future, especially the future of work.

Now workers are continually confronted with change. Self help is repacing corporate or institutional help. Traditional views of labor and management are rapidly changing as the economy moves from an industrial to an informational base. The composition of the work force is changing. New equipment and techniques are making jobs obsolete. More workers are experiencing the reality of changing jobs or entering retraining programs. The prospect of multiple job changes during an occupational life span is becoming certain. Tomorrow's workers will be confronted with even more changes.

One product of this technological explosion has been the reemphasis on the human dimension of the work place. Human resources are increasingly recognized as the least understood and most under utilized element in the work place. Some experts have suggested that the future of the marketplace depends on the ability of business and industry to maximize the personal power of the members of the work force. An increase in personal power is dependent on individuals' abilities to learn new ways to adapt with impending change. Vocational education has always been influenced by technological innovations that influence the requirements of occupations and work environments. Typically a central feature of vocational education programs is specialized job skill training which assumes that vocational training programs are most effective when they emphasize highly specialized skills which are tied to specific needs of employers, particular pieces of equipment, or production processes. Programs of this type have enjoyed a long and strong tradition among vocational educators, and in the

past have often been very successful.

Preparing students to work and live in a technological world creates new responsibilities for vocational educators. In addition to satisfying their traditional functions, vocational educators have to consider two important and related tasks. The first task involves the identification of a body of knowledge and skills that will allow individuals the option of starting at entry level in available occupations or of undertaking more specific education and training. The second task concerns the integration of that body of knowledge and skills into a curriculum which may be implemented in the schools. This extrapolation paper is a response to both of these tasks.

The purpose of this paper is to present a model of a pretechnical curriculum which has as its focus the self-empowerment of the individual and to describe how this curriculum could be implemented in the schools. "Self empowerment" refers to an individual's ability to understand and to deal effectively with career and life options and events as they occur. People's ability to understand and deal with available options and actual events is related to their mastery of three categories of interrelated skills and knowledge which represent the core of our proposed pretechnical curriculum. The three categories are: Generalizable Skills, Transition Skills, and Problem Solving Skills.

Need for a Pretechnical Curriculum

Introduction: A Model for Self-Empowerment

Basic skills are a reflection of Americans' work activities and values. For a long time, it has been relatively easy to revise basic skills as technology and society changed. But now changes are occurring so rapidly that predicting lifelong basic skill needs has become very difficult. In fact, change itself has become the only predictable certainty of the future. Already, the ability to deal with change is critical for many Americans. They are now confronting changes in their jobs, changes in their schooling, changes in their personal lives, and changes in the world around them. Contemporary education must provide opportunities for students to learn to adapt with these changes, and the skills to do so must be considered basic skills. This paper describes a model for preparing students to adapt and cope with change.

Change has always been central to American life. More than a century ago, de Tocqueville remarked that "the American has no time to tie himself to anything, he grows accustomed only to change and he ends by regarding it as a natural state of man" (Pierson, 1938). This social commentary about nineteenth century America seems remarkably apt as our nation approaches the 21st century. Contemporary theorists (Schlossberg, 1984, 1981; Moos & Tsu, 1979; Schneider, 1984; Levinson, 1978; Bridges, 1980; Gould, 1978) have noted that American adults are encountering an increasing number of changes during their lifespans which call for new patterns of behavior or for revisions in their perceptions of self and environment.

Even though our predecessors always accepted and adapted to change, they usually had relatively stable lifestyles. Contemporary Americans, however, are living in the midst of a technological revolution for which the rate of change is accelerating. They will have to be even more flexible, more

versatile, and more adaptable in planning and actualizing their respective careers and lives (Pratzner, 1978; Naisbitt, 1982). They will have to learn how to learn throughout the rest of their lives. Ample support for this assertion is available.

> From Action for Excellence (1983): "We don't believe a high school graduate in 1985 will retire 35 years from now from the same job for which he was hired--during that period he will need to be trained and retrained many times."
>
> A Nation at Risk (1983) stated that, "In our view, formal schooling in youth is the essential formulation for learning throughout one's life. But without life-long learning one's skills will become rapidly dated."
>
> The Paideia Proposal (1982) asserts that, "Learning never reaches a terminal point. As long as one remains alive and healthy, learning can go on and should."

Educational systems will be called upon to play a central role in educating students who can adaptively respond to the changes that the future holds. Parents will expect schools to provide the skills and strategies that their children will need to survive and prosper with ever increasing social and technological change as they enter the world of work. In the monograph Adaption to Work (Ashley, 1980), from the National Center for Research in Vocational Education, it was noted that an inability of many workers in the American labor force was that of adapting to the changes, demands, and responsibilities of work. Business and industry will look to the schools to produce workers who possess and manage skills which contribute to achievement of employers' goals. Education has no alternative but to respond to this

emerging imparative because society will surely hold public schools accountable for accomplishing this important task.

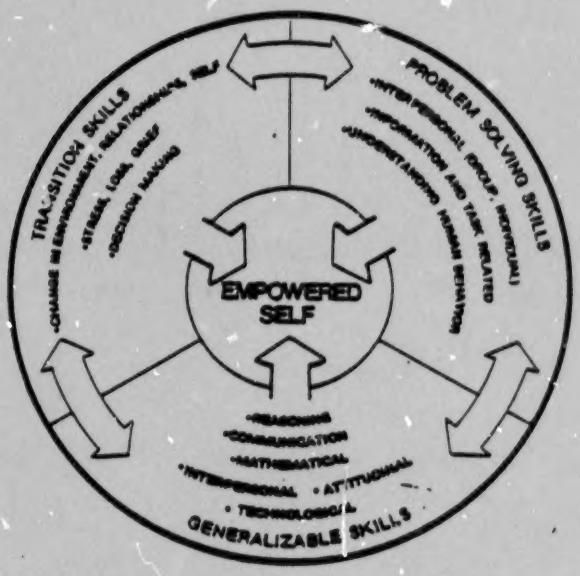
How should the educational community respond to these clear, urgent, and pressing demands? Alternative solutions have been proposed from a variety of sources (Adler, 1982; Botkin, Dimancescu & Stata, 1982; Boyer, 1983; DeBevoise, 1982; Goodlad, 1982; Gisi & Forbes, 1982; Naisbitt, 1982; Pratzner, 1978; Ravitch, 1983; Selz, 1980; Timpane, 1982). Based on a review of these and other resources, our own research, interviews and workshops, the authors have identified a comprehensive model for pretechnical curricula for preparing students to adapt with change. The model has two basic assumptions.

ASSUMPTION: The nature of work in the future will be characterized by constant change, which means that most workers will be employed in several different jobs within or across occupational clusters during their lifetimes. Accelerated change represents a significant factor which must be considered by individuals as they prepare for their initial employment.

ASSUMPTION: Individuals' employability options in the future will be shaped by the acquisition and maintenance of specific classes of skills and knowledge. Three classes of such skills and knowledge have been identified: Generalizable Skills, Problem Solving Skills, and Transition Skills.

The figure below displays three classes of skills and knowledge within which insturctional strategies and pretechnical curricula decisions may be developed.

SKILLS FOR ADAPTING WITH CHANGE



DEFINITION: Generalizable Skills and knowledge (hereafter refered to as Generalizable Skills) actively used in work performance, which are transferable across jobs and occupations and which are instrumental to success on the job and in the classroom. Examples include mathematical, reasoning, communication (written and oral), interpersonal, technological, and attitudinal skills.

DEFINITION: Transition Skills and knowledge (hereafter refered to as Transition Skills) are used to manage life transitions, especially occupationally related ones. They include managing changes in the environment, in relationships, and in oneself; managing stress, loss, and grief; and making decisions.

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DEFINITION: Problem Solving Skills and knowledge (hereafter refered to as Problem Solving Skills) are employed in the resolution of problematic situations including interpersonal problems (group and individual), information and task-related problems, and problems related to people's behavior in cooperative groups.

Two classes of skills from the model are discussed in this report, Transitional Skills and Problem Solving Skills. Generalizable Skills have been described in detail in several current sources, one of which is Greenan's Identification of Generalizable Skills in Secondary Vocational Programs (1983). Generalizable Skills, including the 3 R's of reading, writing, and arithmetic, are crucial for adapting with change, but they are no longer a sufficient education for the workers of tomorrow. We have extended essential skills to include Transition Skills and Problem Solving Skills. These skills will help provide tomorrow's worker the opportunity for life-long employability and well-being.

A transition has been described as an event or nonevent resulting in a change in relationships, routines, assumptions, or roles within the setting of self, work, family, school, health, or finances (Schlossberg, 1984). Adolescents face many transitions: becoming educated, choosing a career, finding first jobs, seeking individual identity. Passage from youth to young adulthood often involves decisions to marry, to drop out of school, to leave parents, and to have children. Throughout their life-spans, change and transition will continue -- changes in values, purposes, and circumstances. As adults, some will lose or change jobs, experience retraining, become successful, encounter illness, divorce or be divorced, develop and change emotional and spiritual perspectives, and adjust to retirement and the challenges of old age. Each of these events will signal a transition in their lives, some inevitable and predictable, many not. Forecasts for the future

signal the certainty of a far greater number of these life transitions for them than their predecessors ever dreamed of encountering. The educational system must help prepare students to cope with these realities by utilizing education as an instrument of change through which they may have the resources and options with which to build and survive the future.

Problem solving is receiving more national attention now than ever before. Daniels and Karmos (1983) found that except for the three R's, problem solving was listed most frequently in the literature and by employers as an essential skill for dealing with the future. Michael Timpane in his report of corporations and public education emphasized the need for teaching young people problem solving skills so they will be ready for further education and training (Timpane, 1982).

Not enough problem solving is occurring in classrooms. In the April 1983 Kappan, John Goodlad remarked that "teacher talk" was by far the dominant classroom activity. "Teachers rarely encouraged student-to-student dialogue or provided opportunities for students to work collaboratively in small groups or to plan, set goals, determine alternative ways of achieving these goals, and the like. The emphasis was on recall not on problem solving or inquiry" (p.552). Goodlad went on to say that each of the 50 states believes in problem solving instruction but very few are doing much with it.

Insufficient preparation in problem solving will have serious implications for many students. Roy Forbes, director of the assessment and evaluation division for the Education Commission of the States, predicted that by 1990 between 900,000 and 2 million high school graduates will not possess the problem solving skills required for employment in a highly technological society (Whimbey & Lochhead, 1984). For students to hold jobs, be retrained, and in general to adapt to a constantly accelerating rate of change in their lives, they will need strategies for how to attack and solve problems.

The model introduced above represents an extrapolation of available knowledge and opinion concerning the future of work and the skills that individuals will need if they are to find work in the future. The purpose of the remainder of this paper is to explicate teh model and to demonstrate its usefulness. This purpose will be achieved by:

summarizing predictions about the future of work and the requisite needs of employees, and identifying the implications of those predictions.

providing criteria for building a pretechnical curriculum which will be responsive to both the needs of employers and employees.

describing how the pretechnical curriculum may be implemented into the schools.

Future of Work: Employer and Employee Needs

Employers and employees have always had interrelated concerns about work. For employers, future concerns will revolve around the need to sustain state-of-the-art production and service capabilities in order to remain competitive within the market. For employees, future concerns will center on the need to find meaningful and satisfying employment and to adapt with changes that occur within or related to the work setting. Based on our review of the literature, however, a variety of different factors are predicted to disrupt the balance that exists between the concerns of employers and employees. Examples include the impact of technological change on the structure of the labor market, the increase in the transitory nature of work, and the emergence of participatory work environments in business and industry. As it will be demonstrated, each of these factors has important implications for the formulation of a pretechnical curriculum.

Structure of the Labor Market

One estimate of the net impact of technological changes has been provided by the AFL-CIO committee on the Evolution of Work (1983). This committee's report, based on reports from a variety of experts from business, industry, and public and private research institutions predicted the formation of a two-tier work force.

> As computers and robots take over more and more functions in the factory and the office, a two tier work force is developing. In some cases, jobs are being upgraded. In many other cases, jobs are being downgraded... At the top will be a few executives, scientists and engineers, professionals, and managers, performing high-level, creative, high-paid full time jobs in a good work environment... At the bottom

will be low paid workers performing relatively simple, low-skill, dull, routine, high-turnover jobs in a poor work environment. These jobs will often be a part of time and usually lacking job security and opportunities for career advancement. (p.8)

The AFL-CIO report continued by reporting two additional characteristics of their labor market projections:

> Between these two major tiers will be fewer and fewer permanent well-paid, full-time, skilled, semi-skilled, and craft production and maintenance jobs which in the past have offered hope and opportunity and upward mobility to workers... (p.4)
>
> Below the two-tier work force is a labor surplus underclass, the workers who don't have jobs and don't have job prospects. There is some movement in and out of this labor surplus underclass, but upward movement is essentially limited to the bottom level of the two-tier work force. (p.9)

Paul C. Craig (1984) of the Ohio State University stated that the work force of the future will require researchers and scientists and "a few highly skilled technical engineers and mechanical machine maintenance people... But the mass of people will not have advanced technical skills" (p.7).

Implicit within these predictions about the structure of the future labor market are assumptions about the types of occupations that will be available to the majority of individuals. The predominant assumption is that there will be increasing numbers of workers who will be limited to low-skilled, routine, high turnover jobs. Henry Levin (1984) of Stanford Unversity predicted that in the future the vast majority of jobs will be low level service occupations such as waiters, sales clerks, kitchen helpers, fast-food workers and cashiers" (p.4).

Rumberger (1984) contends that technological innovations will have a negative net impact on the structure of the future labor market. According to him it will not only reduce the total number of jobs, it will also reduce the skill requirements of most jobs. Moreover, others predict that the reduction of jobs and of skill requirements will be pervasive. It will affect not only specific occupations such as secretaries, bookkeepers, paralegal workers and repair people (Levin, 1984), but entire industries and occupations as well (Faddis, et.al., 1982).

In most instances, the redirection of jobs or skills requirements will involve the dislocation of workers and the incorporation of machines as technical equipment. The net result of this trend is that workers will be limited in both the number and variety of available occupations. Some workers will be able to obtain high tech positions (approximately 3 percent), but the remainder will be limited to occupations that will require only a high school education (Levin, 1984). Most of these jobs will lack security or opportunities for career advancement. In either situation workers will be confronted with the prospect of change; change that will affect not only their work, but almost every other aspect of their lives.

These projections about the structure of the future labor market have important implications for the formulation of a pretechnical curriculum. If it is designed to provide <u>everyone</u> with the capability to live successfully in a technological society, then it must prepare people to adapt with change. Schools need to prepare students to adapt with change. The importance and adaptability for high school graduates was emphasized in a recent report from the National Academy of Sciences entitled <u>High School and Changing Workplace: The Employers View</u> (1984). A panel of economists, educators and employers, "graduates of American high schools need to be adaptable to changes in the workplace more than they need any particular job skill.... This adaptability is by far the most important characteristic of the young person enter-

ing the workplace." (pp.xi-xii). A growing number of people believe that adaptability is most likely to be achieved when students receive a solid basic education as opposed to one that has a narrow vocational focus (Levin, 1984; Rumberger, 1984; Levin & Rumberger, 1983; Lemons, 1984). Vocational education can make significant contributions to the goal of adaptability.

Transitory Nature of Work

Work is becoming increasingly transitory in nature. It can no longer be viewed as a static concept. According to Levin (1984) there are two reasons for this fact. First, we are entering a period of rapid technological change in which both entry-level and high-skill positions are being transformed, often in unpredictable ways. Second, no one can accurately predict which jobs will be available to any particular person over a career of four to five decades, nor can it be predicted which particular jobs or combination of jobs an individual will actually obtain among those that are available.

The certainty of technological change and the unpredictability of its outcomes coupled with the inaccuracy of job forcasting guarentees that most workers will change jobs several times during their lives. Change may be forced (e.g. jobs may be eliminated), or they may be selected (e.g. a new and different position may be accepted). In either instance, workers will be expected to make the necessary transitions both in their work and in their day-to-day living and the transitions will often involve being retrained to do a different job.

The importance of the potential for successful retraining as a necessary characteristic of future workers has been endorsed by industry. As Peter J. Elliman, the Vice-President and General Manager of Lucas Industries, a multinational conglomerate, put it:

> Todays industrial workers must never cease learning and growing. Regardless of what individuals have accomplished or learned up to a point

> in time, in five years their skills will be obsolete and they will have to be retrained . . .industrialists have to deal with their end products for forty-eight years; every five years we have to teach them a new skill. Furthermore, many of these people never really learned how to study effectively so that we can retrain them easily. (Elliman, 1983, p.4)

It appears that workers' best counter to the prospect of "dislocation due to technological innovation" is to exercise a primary human characteristic, the capacity to learn. The ability to apply previous learning to the process of retraining will the landmark characteristic of future workers. Those who possess the ability to learn again and again and again will be better prepared to meet the retraining demands of their employers. For them technological innovations will not seem so ominous. Theodore Schultz, the Nobel Prize winning economist put the issue as follows:

> Mankinds future is not preordained by space, energy, or cropland. It will be determined by the intelligent evolution of humanity... future workers will need to be generalists, flexible enough to change course and train for new careers with a minimum of disruption. (p.)

Given the transitory character of work, it appears that workers may enhance their employment opportunities if they have learned to learn (Toffler, 1970); that is, if they have prepared themselves to be retrainable. Yet, as Ashley, Zahniser and Connell (1984) have noted, many workers, especially dislocated workers, lack this essential skill.

The dislocated workers who are currently suffering from the results of rapid industrial declines characteristically are unionized workers with senority in blue-collar jobs, who earned high wages in manufacturing

> industries. Among the dislocated, females and minorities often are the more disadvantaged and suffer greater economic hardships following the loss of their jobs. In general, many dislocated workers, particularly the older workers, are lacking in their educational backgrounds and do not have skills that are in demand in other occupations. (Ashley, et.al. p.ix)

For workers who have not learned to learn, who have not prepared themselves to be retrained, job dislocation represents only half of their trauma. The other half is relocation. For many dislocated workers the process of relocation is neither easy nor successful. There are many factors that contribute to this lack of success, including their lack of adequate educational background of skills that are in demand in other occupations. Dislocated workers are often ill-prepared to deal with the social, psychological and physical problems that accompany the loss of their positions. Their inability to resolve these work related problems frequently results in increased incidences of depression, grief, alienation, substance abuse, marital difficulties, heart disease, and other stress-related illnesses, including increased incidences of depression, grief, alienation, substance abuse, marital diffulties, heart disease, and other stress-related illness, such as increased rates of suicide (Ashley, et.al., 1984). Their lack of job flexibility is paralleled by a lack of flexibility in other areas of their lives. Among their many other needs that must be met if they are to be relocated, most dislocated workers will need to be retrained if they are to reenter the work force in new positions (Ashley, et.al., 1984; Lemons, 1984).

The plight of the dislocated worker has several important implcations for the articulation of a pretechnical curriculum. First, as Ashley, et.al. (1984) have noted, "future economic conditicns and technological changes are likely to increase the numbers of adult workers who will face the problem of job

dislocation or skill obsolescence throughout their work lives." (p. xi) Second, the prospect of becoming a dislocated worker places special emphasis on the skills and knowledge that will enable individuals to learn, i.e. be retrained. Third, the skills and knowledge that individuals need to adapt with the transitory character of work will include those that relate to the social, psychological and physical problems that are associated with loss of position. Finally, as noted by Rumberger (1984), job displacement will occur at all levels of the economy, not just at the bottom. Thus, future workers need to possess the skill and knowledge that will enable them to participate fully and effectively in a transitory work force.

Participatory Work Environments

The emergence of participatory work environments which are characterized by the collaborative efforts of labor and management, the importance of personal involvement in the production process, and the full expression of one's humanity through one's work represents one of the important products of the revolution of high technology innovations. While this particular development may appear to be an anomaly of this particular technological age, it represents an altogether human reaction to an environment marked by rapid drastic change (Hedist, 1974, as noted by Wirth, 1984). The central theme of this trend, which is the importance of people, has been acknowledged by economic and labor theorists (Wirth, 1977; Schultz, ; Gyllenhammer, 1977) and by industrialists (Elliman, 1983; Freiz, 1983). The thrust of the theme as stated by Gyllenhammer (1977) is as follows:

> People don't want to be subservient to machines and systems. They react to inhuman working conditions in very human ways: by job-hopping, absenteeism, apathetic attitudes, antagonism. The younger the worker is, the stronger his or her reactions are likely to be. People entering the work force today have received more education than ever before in history.

> We have educated them to regard themselves as mature adults, capable of making their own choices. Then we offer them virtually no choice in our overorganized industrial units. For eight hours a day they are regarded as children, ciphers, or potential problems and managed and controlled accordingly. (p.4)

One alternative to a machine or system centered industry is one that is person centered. A person-centered industry has different economic and industrial assumptions. From an economic perpective, it assumes "a new economics which starts from a committment to make the fullest practicable use of whatever talents are inside people instead of starting from a consideration of the most profitable use or misuse of the elements inside the thin and fragile crust of the planet (Wirth, 1977, p.). From an industrial perspective, it assumes a commitment to obtaining the key elements that workers and managers need if they are to create "good work" for themselves (Wirth, 1981). Examples include:

> Adequate elbow room. Enough room to feel autonomous, but not so much room as to seem disconnected from the overall task.
>
> Chances of learning on the job on a continuous basis.
>
> An optimal level of variety.
>
> Conditions that promote help and respect among co-workers.
>
> A sense of one's own work meaningfully contributing to the welfare of society.
>
> A desirable future.

The collective goals of a person-centered work place have been translated to the American work place through Quality of Work Life (QWL) developments (Pratzner, 1984). According to Pratzner (1984):

> QWL developments embody a philosophy, a set of values and models, and a multitude of practices and techniques for understanding, explaining, and affecting how work is organized and carried out. QWL developments and participative management are democratizing the work place and involving employees in more decisions that effect their work, through the use of quality circles, problem-solving task forces, labor management committees, group incentive plans, job redesign, and a variety of other approaches and techniques. (p.3).

Quality of Work Life programs create two broad areas of job skill demands for employees: group problem solving and the organization and management of production (Pratzner & Russell, 1983). Group problem solving incorporates a number of other specific skills, including interpersonal skills, group process skills, decision making, communication and reasoning. Organization and management of production also includes a collection of specific skills. Examples include business economics, management, statistical quality control, and introduction to QWL.

Considered collectively, these several skills represent the foundation of socio-technical literacy (Pratzner, 1984). According to Pratzner:

> socio-technical literacy emphasizes a balanced concern for the social, human aspects of work, as well as the technological aspects, and an appreciation of their interactions. It includes development of (1) group problem solving skills (eg. interpersonal and group process skills, problem solving and decision making, planning, and communication), and (2) skills in the organization and management of production (eg. skills in business economics, business operation, and statistical quality control). It also includes (3) an understanding of the philosophical under-

pinnings and consequences of the shift from a mechnaistic, technological, scientific management perspective of work to a high involvement, participative management perspective. (p.56).

Quality of Work Life programs are changing the characteristics of work by influencing the ways in which workers relate to one another and relate to management and to the production process itself. Programs of this type require employees with sufficient socio-technical literacy to make such efforts effective. Socio-technical literacy transcends the performance of a single specific job, or the operation of a particular piece of equipment, or a certain part of the production process. Its focus is more broad and includes the human and business aspects of production, as well as the technological aspects. The essence of socio-technical literacy is contained in the following description of an ideal worker:

> I am looking for individuals who can read and write...My ideal worker would also have common sense, understand my industry, be willing to accept that he or she will not reach the top in a year, and realize that he or she will have to work hard for the rest of his or her life...who will accept me as an ally and not as an enemy. I want this person to have been taught some of the basic social graces. (Elliman, 1983, p. 10)

The emergence of QWL programs also has important implications for the formulation of a pretechnical curricula. Assuming that QWL programs will remain an important dimension of high involvement industries, the demand for socio-technical literate workers will increase.

Summary

Three factors which are predicted to influence the future of work were discussed. They were the impact of technological change on the structure of the labor market, the increase in the transitory nature of work, and the emergence of participatory work environments. Each of these factors has important implications for the development of a pretechnical curriculum. A summary of the specific conclusions of this section and the implications of those conclusions for the formulation of a pretechnical curricula are listed below.

Conclusions	Implications
- Technological innovations will create new jobs in high-tech occupations; there will also be an increase in the number of low-skilled jobs.	- A pretechnical curriculum must be able to address the needs of both types of workers.
- Most workers will change jobs or occupations several times during their lifetimes, which will require them to be periodically retrained.	- A pretechnical curriculum needs to emphasize the skills and knowledge that will allow workers to benefit from retraining programs.
- For most workers, occupational changes will involve differing types of psychological problems which may limit their future employment opportunities.	- A pretechnical curriculum must minimally prepare future workers to understand and cope with the psychological problems associated with occupational changes.
- QWL programs are placing new skill demands on workers, including group problem solving and the organization and	- A pretechnical curriculum must prepare students to participate successfully in the work place, thus it

management of production. They are also helping to change the basic character of the work place.

must be responsive to the new skill demands that are experienced by workers.

Criteria for Curricular Decisions

Utility and Personal Options

High Tech innovations are expected to cause substantial changes in the structure of the labor market as well as in the characteristics of work settings. These changes have led us to challenge traditional approaches to vocational curricula such as specialized job-skill training programs and to set forth new criteria for judging secondary vocational educational curricula. The four criteria are: utilty, personal options, transferability, and psychosocial value.

It is an important task for vocational educators to identify a body of knowledge and skills that individuals must possess to live adaptively and effectively in a technological world. How does the content of a pretechnical curricula do this? It is our position that a pretechnical curricula will contribute to adaptability of individuals to the degree that they recognize the utility of the curricula for their personal situations. The criteria of utility, then, represents one basis for identifying the core skills and knowledge that will be needed by individuals if they are to live and work fully and effectively in a technological world.

Utility, however, will mean different things to different people. For some, utility may represent the assurance of employment in an entry level position in a particular business or industry. For others, utility may mean receiving skills and knowledge which are prerequisites for post-secondary training in a specific technological field. Still others may view utility as the skills and knowledge that will give the assurance of career flexibility throughout their lifetime. A pretechnical curriculum must be responsive to each personal definition of utility.

Personal option is a second criteria for identifying the contents of a pretechnical curriculum. It is seen as the condition of having an array of aptions from

which to choose. Personal options in one's work should give a wide domain of alternatives to choose from so that people can try to reflect their own interests, values, and strivings in the work they do. For one's job to reflect one's self would be an immense benefit for people.

Taken together, the criteria of utility and personal option represent a practical basis for indetifying the content of a pretechnical curricula. The essence of this process has been expressed by Levin (1984)

> We cannot predict accurately which jobs will be available to any particular person over a career of four to five decades, nor can we predict which particular job or combination of jobs an individual will actually obtain among those that are available. Given these circumstances, education must be provided that will allow individuals the option to starting at entry level in the available occupations, and of undertaking education and training as needed in order to move into higher level occupations. (p.21 emphasis added)

Transferability

Tranferability of educational outcomes to the work place has drawn the attention to researchers who have attempted to identify those skills that are transferable from school to work (Greenan, 1983) and across work settings (Pratzner, 1978). After investigating the relationship between occupational adaptability and tranferable skills Pratzner (1978) concluded the following:

> Schools cannot prepare students for all unknown future contingencies. But it does seem reasonable to expect them to help students develop their individual attributes, potentials, or capacities to levels of proficiency useful in a wide range of situations. By such development they may be adaptable and better able to perform successfully in changing environments.

> Having transferable skills will not guarantee successful adaptability, but should facilitate it. To the extent that individuals perceive similarities among jobs and are able to transfer their skills and knowledge effectively, the time and costs associated with supplemental training or retraining should be reduced and reflect a savings to employers and individuals alike. (p.).

A good deal of research has focused on the identification of the skills and knowledge that are useable across a wide range of situations. One of the more recent and carefully defined investigations was completed by Greenan (1983).

Greenan's research focused on the generalizability of certain basic skills across different vocations. For Greenan, a skill is generalizable if it is basic to a particular occupation or training program, if it is necessary for success in a particular occupation or completion of a particular program, and if it is applicable across occupational settings and clusters. Greenan developed an instrument to measure the generalizability of specific skills in each of the following catagories: Mathematics, Communication, Interpersonal Relations, and Reasoning. The instrument was administered to teachers in five vocational training areas (agricultural occupations; business, marketing, and management occupations; health occupations; home economic occupations; and industrial occupations). Based on the results of his study, Greenan (1983) concluded that

> "There is a core of mathematics, communication, interpersonal relations and reasoning skills which are basic to, necessary for success in, and transferable across several secondary vocational training program areas and programs; most of these core skills are very important and highly generalizable..." (p.57)

The importance of transferability has also been recognized by industrialists. Elliman (1983) stated that:

> I would much prefer that the schools concentrate on teaching students the basic transferable vocational skills that they will need when I teach them the applied technology I utilize. The basics are the skills that business and industry can most capitalize on in years to come. (p.4)

The criterion of transferability is a necessary but not sufficient criterion by which to assess curriculum content. Utility can become too narrow a criteria by which to evaluate curricula content. A curricula that has utility may have students learning to use specific tools, repair highly specialized equipment, or gather specific types of data. On the other hand, transferability in a curriculum implies that a student may learn to use tools which are applicable across many jobs or job clusters, repair equipment which is used in many areas, and gather data in many ways using microprocessors, computers, and electronic data processing. Transferability helps students work and learn, be more easily retrained, and gain confidence that change is not an overwhelming threat but merely a part of one's life.

Psychosocial Value:

It is increasingly clear that job preparation for the future will have to influence information and skills that are related to the psychosocial issues of work and work loss (Baker, 1982). Several factors contribute to the emergence of this need: the development of QWL programs (Pratzner & Russell, 1983), the incidence of worker dislocation and its subsequent psychological stresses (Ashley, et.al., 1984), the prospect of multiple changes in job or occupation in a lifetime (Levin, 1984), and the need for individuals to participate fully

in a rapidly changing society (Rumberger, 1983). Future workers will need to be prepared to cope with these and other work related factors that involve psychosocial issues.

It may be presumptuous to assume that every worker will have a difficult time dealing with psychosocial issues that will confront them. Nevertheless, the criteria of utility, personal option, and transferability point to the necessity of systematically including psychosocial content within a pretechnical curriculum. At a minimum the psychosocial content must focus on the development of character (Silberman, 1983), on individual problem solving, group decision making (Pratzner, 1984), and on managing transitions (Brammer & Abrego, 1981).

According to Silberman (1983) "the acquisition of appropriate personal skills and attitudes is just as important outcome of vocational education as is the acquisition of technical and basic literacy skills." (p.). Frequently mentioned personal attributes are autonomy, courage, and cooperativeness. For Silberman (1983), autonomy refers to the ability to act as a mature, rational, inner-directed, independent person and to be responsible for one's own actions. Autonomous people think before they act, and require minimal supervision. They can forego short-term gratification in favor of long-term lasting benefits. They are also capable of self-directed learning. He defines courage as the ability to overcome fears and to confront problems directly--doing what is necessary even if the actions are unpopular. People with courage have the ability to cope with problem situations or emergencies. Such people do their duty when long-term interests are at stake even when the short-term consequences may be aversive. They are self-confident and not afraid to seek help from others when they need it. Finally, Silberman (1983) uses cooperativeness to describe workers who are warm, friendly, and supportive. People who are prompt, dependable, loyal to the group, and conform to group norms in their dress, manners, and personal habits

are traits which enhance group membership. They possess good interpersonal skills, good work habits, and positive attitudes. They accept supervision, and their behavior is consistent with the orderly conduct of business. They have good interpersonal relations and share a strong sense of community.

Acquisition of the characteristics described within these three attributes represent a potential for personal development within a pretechnical curriculum. Having the personal qualities of being self-directed and responsible, self-confident and responsive, interrelated and participative with others appears to have great utility for present as well as future workers. It is this utility that magnifies the importance of including psychosocial skills and knowledge in a pretechnical curriculum.

The personal qualities that are important for workers to possess which were identified by Silberman (1983) are not dissimilar from the requisite QWL skills identified by Pratzner & Russell (1983). As noted earlier in this paper, QWL programs represent an alternative for organizing and performing work. They require that workers possess new and different sets of skills and knowledge, including individual problem solving skills and group problem solving skills, and the skills to organize and manage production. These represent the foundation of socio-technical literacy which emphasizes a balanced concern for the social and human aspects of work as well as the technological aspects, and an appreciation of their interactions (Pratzner, 1984).

Applying the Criteria to Programs

The Center for Occupational Research and Development (CORD) (1983) has developed a curricula that contains utiltiy and transferability through basic skills and incorporates personal options through advanced courses. After demonstrating a suitable proficiency in the requisite skills, individuals complet-

ing the CORD curriculum begin a technical curriculum which encompasses twelve core areas (eg. electricity, mechanics, materials, thermics, etc.). After completing this technical core, students study a self-selected high tech area.

According to current estimates, the CORD curriculum is suitable for one out of every 10 students (AFL-CIO, 1982). CORD lacks transferability across a sufficiently wide range of different job clusters and it lacks psychosocial value because the material does not adequately emphasize the development of the human potential and self-empowerment of workers.

Other programs, in addition to CORD, have also been reviewed. Table 1 below summarizes our evaluations of them relative to the four criteria of utility, personal options, tranferability, and psychosocial value.

TABLE 1

Four Criteria Applied to Curricular Programs

	Utility	Personal Options	Transferability	Psychosocial Value
CORD	X	X		
State of Arizona	X		X	
Canada Life Skills	X	X	X	
San Diego Program	X		X	

Note to Bill: We shall extend this list in the final version.

Summary

The curricular content of vocational education has always had an important role in the preparation of secondary students for work. Traditionally the curriculum has been related to specialized job skills training. Recent technological innovations, and their resultant impact on the world of work, create the need to reevaluate the traditional curriculum against the four criteria of: utility, personal options, transferability, and psychosocial value. Such criteria have important implications for the formulation of a pretechnical curriculum. These criteria coupled with our experience with current writings, views of education, business people, teachers, students, and unemployment victims have led us to three categories of essential skills for helping people to cope with their work-lives: Generalizable Skills, Transition Skills, and Problem Solving Skills. There is self-empowerment in these skills. It can be seen that the stated need for inclusion of Generalizable Skills in the vocational education curricula satisfies the criteria of transferability and personal utility. The inclusion of the category of Problem Solving Skills satisfies the criteria of transferability, personal option and psychosocial value. Transition Skills satisfy the criteria of transferability, psychosocial value and personal utility. It is the interrelatedness of these three categories of skills which provide a comprehensive framework for self-empowerment of the individual and curricula decisions. Self-empowerment is the key assumption for guiding schools in preparing your people for their futures. People can help themselves to lead more meaningful, balanced and productive lives.

It is ultimately the individual who must apply the new techniques in the workplace. People must not become slaves of technology and change. A machine, a process, a system is no more effective than the people using it. The human factor in education and work must stand above all others.

Transitions

During the last decade educators have been made aware that students lives are marked by change and transition. Forecasts for the future signal the certainty of greater numbers of life transitions. Occupationally related transitions will become the rule rather than the exception for most workers. They will interact with and be further intensified by the transitions which have resulted from changes in societal norms (Naisbitt, 1983). Educators cannot be expected to prepare students for all possible unknown future contingencies. Nevertheless, as noted by the National Academy of Sciences (1984), society, business, and industry will expect educators to help students develop skills which will prepare them to cope, adapt and change with their environment. The person-machine-change relationship is critical to the successful management of the future for students, educators, business and industry. It is for this purpose that the class of Transition Skills has been identified and a framework for educating for attainment of those skills introduced. The aim of this class of skills is consistent with the image of vocational educators serving the needs of employers, the labor market and the individual. It maximizes the preparation of the individual for a life time of transitions.

A transition results in changes in relationships, routines, assumptions, or roles within the setting of self, work, family, school, health, or finances (Schlossberg, 1984).

The U.S. economy is undergoing a major restructuring, and the implications for the individual worker are serious. As a result of foreign competition, changing world markets, and consumer preferences, American's economic position

in the world has eroded and many workers in some major manufacturing industries including steel, automobiles, rubber, textiles, radio and television receivers, and electrical equipment have lost their jobs and have been forced to suddenly change their occupations and life styles (Pratzner & Ashley, 1984, p. 5). Simultaneously, the advent of high technology insures continued and accelerated change in the nature of available jobs.

> The increased use of industrial robots, office automation, microelectronic devices, and computerized information and telecommunications systems, will not only affect where and how we live, and what we purchase, but also how we work. The impact of changing technology, expecially the continued expansion of computer applications in the work place, will affect the skill requirements and work styles of millions of workers over the next ten to twenty years. New technology will in some cases reduce the skill requirements of some occupations, especially those involved with more routine and repetitive functions such as parts assembly, equipment operations, signal monitoring, and information handling functions. Other occupations involving the functions of planning, evaluating, analyzing, interpreting, troubleshooting, and maintaining complex systems will likely experience an increase in skill requirements (Pratzner & Ashley, 1984, pp. 5-6).

Change is increasing in our social institutions and will continue to increase. Traditional roles of men and women are being more rapidly transformed, more women are entering the workforce, family units tend to have less stability, and traditional values and practices are continually

challenged and rejected by some segments of the population and renewed by others. Occupationally-related transitions will interact and be intensified by transitions resulting from such changes in societal norms and trends which began in the 60's and now are becoming commonplace in our society. Imagine, for example, the coping skills needed by a person who must relocate in order to maintain present income at the same time that such a move would be detrimental to the spouse's occupational progress. Life transitions are no longer as predictable as they once were, and they tend to be more complex. Accordingly, skills for managing transitions will become increasingly important for our young people as they enter a work world and a social world in which acceleration of change is the only predictable variable in their future lives. To survive, individuals will have to learn new ways to adapt and new ways to cope with their environment.

The educational system must help prepare students to cope with these realities by utilizing education as an instrument of change through which they may have the resources and options with which to build and survive the future. The challenge for educators seems overwhelming as powerful alternatives to public schooling threaten to change the social context of education. The idea of sociotechnical literacy (Pratzner, 1984) no longer rests on the teaching of a fixed body of information in a fixed routine but instead on the incorporation of ways of transforming students' abilities to function in a changing world, to learn how to learn for a lifetime, to cope, manage, and adapt to the challenge of an uncertain future. It is the responsibility of educators to identify and pass on those skills.

The class of Transition Skills refers to those skills which are used to manage life transitions, especially occupationally related ones. Subsumed within this class of skills are those which include managing changes

in environment, relationships and the self; managing stress, loss, and grief; and making decisions. The framework below is an attempt to introduce a comprehensive approach to handling transitions which may be incorporated in the public school curriculum and a) utilizes an understanding of adolescent development, b) organizes the knowledge and process necessary for maximizing an individual's ability to adapt and manage transitions across settings (personal, interpersonal, workplace, institutional, or community) and c) focuses on the self empowerment of the individual to understand and deal with events as they occur.

Managing transitions depends upon people's ability to successfully acquire and mobilize the skills that will enable them to adapt with change. These skills are identified in each step of the framework. Each step of the framework focuses on acquisition of a series of skills which maximizes management of transitions and prepares the individual to manage future ones. The four steps identified in this framework are:

Step 1. Identify the Transition

Step 2. Identify Coping Resources

Step 3. Identify and Choose Ways of Managing the Transition

Step 4. Trial, Integration, and Self-Transformation

The framework, as it exists may be utilized by educators either through a questioning format (see Expanded Model) or through development of curricula based upon the understanding of the four steps of the framwork (Table 1). The introduction of the framework will be accomplished through the (a) presentation of the Expanded Model, (b) presentation of the Framework for Incorporating Transition Skills into the Curricula, and (c) presentation of a simulation which represents a viable instructional method for teaching transition skills as well as a format for clarifying the four steps of the framework. The expanded

framework consists of a series of questions which attempt to accomplish the outcome variable of each step. The Framework for Incorporating Transition Skills into Curricula (Table 1) identifies the components of the framework with requisite skills and outcome variables. The simulation represents a synthesis of the skills and outcome variables as they are utilized relative to a real-life setting.

Framework for Incorporating
Transition Skills into the Curricula

Components of Framework	Skills Necessary to Attain Mastery of Individual Component of the Framework	Outcome Variable
	The individual will:	
I. Identify the Transition	- Identify Type of Transition A. Anticipated/Developmental B. Unanticipated C. Chronic Hassle (Schlossberg, 1984) - Identify Setting A. Self B. Family C. Work D. Health - Identify Relationship of Person to the Transition A. Self B. Other C. Interpersonal D. Community	- Assessment of Stress - Assessment of Impact of Event on Assumpt
II. Identify Coping Resources	- Identify Support Systems A. Internal B. External - Identify Possible and Actual Coping Responses A. Immediate/Short Term B. Future/Long Term - Assess Impact of Personal Variables A. Socioeconomic status B. Psychological Resources (Development - Ego Strength) C. Committments, Values	- Mobilization of Resources Necessary to Assist in Management of Transition - Identification of Needs which must be me to Cope and Adapt - Enhancement of Personal Awarenesses Necessary to Respond to Transition - Regaining Control Over Stress and Meanin of Transition

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Components of Framework	Skills Necessary to Attain Mastery of Individual Component Framework	Outcome Variable
I. Identify and Choose Ways of Managing the Transition	- Examine and Identify Alternatives for Coping A. Support Groups B. Counseling C. Restructuring Support System D. Learn New Coping Skills (Exercise, Relaxation, Time Management) - Utilize Problem Solving Model A. Identify Problem B. Brainstorm Possible Solutions C. Choose Tentative Solution D. Carry out Tentative Solution E. Learn - Utilize "Neutral Zone" A. Identify What You Really Want B. Find Time To Be Alone	- Increase Ability to Make Effective Decisio Regarding the Transition - Increase Awareness of the Options For Transition Management - Increase Ability to Reapproach Work, Love, Play with Renewed Energy
IV. Trial, Integration, Self Renewal	- Act Upon Identified Coping Strategy - Identify Learnings From the Transtion A. About Self B. Others C. Assumptions - Evaluate Action - Reevaluate Plan If Necessary	- Learn From Current Transitions Ways of Transferring Skills to Future Transitions - Discover Strengths About the Self - Return to Equilibrium of Pretransition Environment

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Model for Handling Transitions

I. IDENTIFY THE TRANSITIONS

- What has ended? (something personal, interpersonal, family, school, friends)
- How much stress are you under? What is causing it?
- What fears do you have? Be specific.
- Describe the transition as best as you can.
- What kinds of things are changing in your life? (people, job, school, values)
- What is the impact on you? How do you feel about the transition?

II. IDENTIFY COPING RESOURCES

- Who can help you?
- Who could provide a personal support network? (emotional, physical, group, individual)
- How can you help yourself?
- What are some of your options? List them.
- Will preplanning help you cope with the hardest part of the transition?
- Remember the 5 main steps for solving a problem.
  1) Understand the problem (transition).
  2) Brainstorm for solutions.
  3) Choose a tentative solution.
  4) Implement the solution.
  5) What did you learn?
- What obstacles do you have to overcome in order to change? (financial, psychological, interpersonal)
- How might you benefit or not benefit from the transition?

III. IDENTIFY AND CHOOSE WAYS OF MANAGING THE TRANSITION

a) What are various alternative actions for coping?

° Maybe a problem has to be solved. If so, use the 5-step model.

° Individual or group counseling is always a possibility.

° Do you need to learn new coping skills? (relaxation skills, exercise program, time management, health care, etc.)

b) Examine the positive and negative consequences of all planned actions.

c) Are you taking full advantage of the "Neutral Zone"?

° Find a regular time to be alone and to reflect on the transition.

° Identify what you really want.

° Reexamine your values and your goals.

d) What do you know about yourself that you can use in managing the transition?

IV. TRIAL, INTEGRATION AND SELF-TRANSFORMATION

° As you try things out, who can you discuss them with?

° In what ways is this a positive experience? A negative one?

° How are you different?

° What did you learn from this experience? What did you learn about yourself?

° Is your grief or disappointment part of a healing process?

° What are some options open to you if you think you are not managing the transition well?

° Can you accept the transition and go on with your life?

Simulation:

The following represents a simulation used with counselors of displaced workers. This simulation is based upon the topic of loss of a job, but is easily adaptable to reassignment or retraining. Each step of the transition framework will be identified and clarified during discussion of the simulation Space constraints prohibit an in-depth discussion of the theoretical foundation and some of the transition framework.

Step 1: Identify the transition

Every transition begins with an ending (Bridges, 1980). That is an event occurs which signals an end of the way things were. Workers who have lost their jobs face the end of worklife as they have known it and face the uncertainty of unemployment, retraining, changes in self image, and changes in homelife.

Assessment of stress and impact of the transition on individuals' assumptions about themselves is the necessary outcome of this component. This assessment may be accomplished by identifying (a) the type of transition, (b) the setting and (c) the relationship of the person to the transition. The type of transition generally associated with job loss is an unanticipated event. An unanticipated transition is a nonscheduled event and generally is not predictable. This is different than an anticipated transition which may occur predictably over a life span and is more developmentally related; for example, graduating from a technical program, getting a first job, or getting married.

To identify the transition setting the individual examines the primary arena in which the event is based. Loss of a job takes place initially in the setting of work, but the stressors of job loss soon impact upon all other

identified settings (self, family, health, economics). The relationship of a person to the transition is central to assessment of the impact of the transition on an individual's assumptions. For example, loss of one's job is more stressful than having a friend lose a job.

Step 2: Identify coping resources,

The process of coping with transitions provides the individual with the ability to manage future transitions. Step two is specifically designed to enhance the personal awarenesses necessary to maximize one's ability to adapt and respond to transition and allows the individual to regain control and meaning of the transition. To accomplish this the worker who has lost a job may first identify the support system - internal and external.

Initially an individual may rely solely on a spouse or immediate family members to provide emotional support; however, optimumly this support system may need to expand the support system to include other options such as; friends, relatives, clergy or support groups which deal with the effects of structural unemployment.

Second, identify possible and actual coping responses. Initially, an individual who has lost a job may experience a range of responses which are an attempt to modify, control or manage the stress (Pearlin and Schooler (1978). Such responses as anger, hostility, denial and anxiety are common. As time passes responses of depression, sadness, isolation, withdrawal and apathy become more prevalent. These coping responses represent but a few options available to the individual and translate into behaviors which an individual does in their own behalf when confronted with change. Third, the worker may also assess the impact of personal variable on the transition.

Psychological resources, personal and financial commitments, and values an individual has will also impact on the individual's ability to regain control over the stress of the transition.

Step 3: Identify and Choose Ways of Managing the Transition.

At this stage the displaced worker proactively goes about examining and identifying alternatives for coping with the job loss. The worker may utilize a support group or choose to learn new coping skills and then utilize the problem solving model to deal with specifics of a job search, money management or family relationships. This component is essential to increase the individual's awareness of options for transition management, to increase the ability to make effective decisions regarding the transition, and to increase the motivation to reapproach work, love, and play with renewed energy.

The utilization of the "Neutral Zone" in this stage is a time-out from the proactive approach to transition management. The purpose of the "Neutral Zone" is to reflect on what the individual might really want. It is a time to reexamine how ones values and goals integrate with the decisions about to be made. For example, the individual who has lost a job may discover that several options are available-going back to school to enhance skills, moving to a different location for a similar job, or retraining with the same company for a different job. After going through Steps 2 and 3 of the framework, the individual is aware of the consequences, advantages and disadvantages of each choice. Entering the "neutral Zone" gives the individual time to think about the choices to be made.

Step 4: Trial, Integration and Self-Transformation.

This step begins with the implementation of the decision. If the individual who lost a job chooses to return to school for training there are a number of new experiences , people, and environments that will be encountered.

Knowing how to utilize the support system that was identified in Step 2 may be paramount. Awareness and evaluation of the experience of the decision is a necessary componant of Step 4. The individual may realize that the first choice for managing the transition is not appropriate and need to return to Steps 2 or 3 to choose again or change options..

If the individual finds the first option appropriate, it becomes necessary to evaluate what one learned from the transition, how one is different as a result of the transition, what strengths one possessed that aided in transition management, and the degree of acceptance one has for the transition.

Utilizing Step 4 of the transition model enables the individual to return to the equilibr ium that was experienced in the pre-transition environment with renewed awareness and skills necessary to cope, manage and adapt to future transition and change.

PROBLEM SOLVING

The importance of problem solving in vocational education is receiving more national attention now than ever before. For example, Daniels and Karmos (1983) found that except for the three R's, problem solving was listed most frequently in the literature and by employers as an essential skill for dealing with the future. Pratzner (1984) has stated that "The first priority is for secondary level vocational education to offer good education in reading, writing, computing, listening, and problem solving" (p.6).

Ann Brown from the University of Illinois conducted an interview with Edward Binet (Brown, 1984) on the teaching of problem solving skills: Binet said:

> What I object to in traditional classes is that it is the teacher who produces, and the student who passively listens. Such a lesson has two faults: it does not impress the student other than by its verbal function, it gives him words instead of making him deal with actual objects, and it appeals only to his memory, reducing him to a passive state. He doesn't judge, doesn't think, doesn't invent, and doesn't produce. He needs only to retain. His aim is to repeat without mistake, make his memory work, know what is in the lecture, in the textbook and reproduce it. The result of such practices are deplorable: e.g., a lack of curiosity for what is not in the book or lecture; a tendency to look for the truth only in the book, the belief that one is doing some original research by going through a book, too much repect for the writer's opinion, a lack of interest in the world and the lessons it gives, a naive belief in the power of simple formulas, a difficulty to adapt oneself to contemporary life, and, above all,

a static regimentation unwelcome at a period when social evolution is so fast. (pp. 14-15).

Something is being done about problem solving by business and industry. In 1983, General Motors trained approximately 50 percent of its employees in problem solving skills. Kathy Long, Director of Research and Development for GM, said in a personal interview (1983) that the training has been successful, that productivity and positive attitudes have both increased, and that General Motors is going to devote more time and money to problem solving training. The training has improved worker competency, enabled workers to diagnose and solve job-related problems, taught them to examine their own behavior and consequences of it, and has helped workers to be more cooperative with each other in solving problems (Guest, 1979). The Center for Public Resources, in its report Basic Skills in the United States Work Force (1982), identified other corporations and also schools which are currently involved in problem solving training.

A Model for Problem Solving

For students to hold jobs, to be retrained and in general to adapt to a constantly accelerating rate of change in their lives, they will need strategies for how to attack and solve problems. Possession of at least one general model for solving problems is one essential strategy. There are many different models. The one we have developed is given below. It is based on problem solving models from General Motors (Kolb & Baker, 1980), from G. Polya's book How to Solve It (1957), and from Thomas Gordon's book Teacher Effectiveness Training (1974). Our model has five steps.

Five Step Model for Solving Problems

1. Understand the Problem

   - o If people are involved, then there should be explicit agreement among the people on what the problem is.
   - o If appropriate, analyze the problem for possible causes. (In mathematics causes are usually not involved.)

2. Brainstorm for Possible Solution Strategies

   - o No evaluations or judgments should occur here. This should be a free-wheeling act of generating ideas.

3. Choose a Tentative Solution Strategy

   - o For "people" problems, consequences of behaviors and solutions must be carefully considered.
   - o If people are working out an interpersonal problem, then the tentative strategy will likely be a compromise.

4. Carry Out the Tentative Strategy

   - o In implementing most strategies involving people, it is important to decide, "Who, does What, When."

5. Learn

   - o Immediately and over time think about what can be learned from the experience. What are the implications of what has been done?
   - o If appropriate, evaluate the effectiveness of the solution. (You may have to start over.)

At the beginning, we have our students follow the Five Step Model, step by step. Later on they are encouraged to freely use their own creativity and intuition to solve problems since no single model is directly applicable to all problems.

The Five Step Model is currently being used by students for their academic work and for their interpersonal lives. But is the model also practical for the work place? The answer is "yes". Students use it in their part-time jobs, and General Motors uses it to get people to work together to solve problems. Employees cooperate in GM's Employee Participation Groups to solve on-the-job-problems. In a 1983 personal interview, Kathy York of GM's Research and Development Division stated that competition among workers often turns out to be a liability. "They work separately against each other. We need our employees to work together to solve problems. That will increase their job competence." The problems that the groups focus on are not generally psychological ones; they are job-related problems. Workers, supervisors, managers, and executives get involved in the groups. Whoever is being affected by the problem or the solution is in the group. They use a model very similar to the Five Step Model.

The Need for Transfer

For general problem solving, a model is necessary but it is not sufficient. Transfer is one of the deficiencies. Schools teach problem solving, but most students have difficulty transferring their problem solving capabilities from one setting to another (Johnson, 1984; Snowman, 1984). We believe there are tow major reasons for lack of transfer:

1. Not enough diverse kinds of problems are given to students to encourage transfer over a wide range of settings. Only math problems are given, or science problems, or social studies problems, and so on. These problems are context bound. They are too similar to each other. There are many commerical programs for teaching problem solving, and they provide a wide variety of problems. The June 1983 issue of the Kappan listed more than 30 programs, video-taped presentations, computer-assisted instruction, instructional programs for teachers, and materials for student use. Other excellent sources are:

   - The Edward deBono School of Thinking, P.O. Box 711, Larchmont, NY 10538.
   - Institute of the Advancement of Philosophy for Children, Montclair State College, Upper Montclair, NJ 07043.
   - The Productive Thinking Program from the Charles E. Merrill Publishing Company in Columbus, OH.
   - Problem Solving and Comprehension by Arthur Whimbey and Jack Lochhead, The Franklin Institute Press, Philadelphia, PA, 1979.
   - More Life Skills by Joan Hearn, Advanced Development Division, Employment and Immigration, Ottawa, Canada, K1A 0J9, 1982.
   - Problem Solving in School Mathematics, 1980 Yearbook, National Council of Teachers of Mathematics, Reston, VA.
   - Instrumental Enrichment by Reuven Feuerstein, University Park Press, Baltimore, MD, 1980.
   - The New MCAT Student Manual (Quantitative Skills) from the Association of American Medical Colleges, Washington, DC, 1984.
   - Medical College Admission Test (Quantitative Skills) by Morris Bramson and Lawrence Solomon, Arco Publishing, Inc., NY, 1982.
   - A Complete Preparation for the New MCAT, Vol. II (Quantitative Skills) by Beryl Brain, Drew Love, and Philip Kelleher, Health Professional Education Service, Inc., Bethesda, MD, 1981.

If Molitor (1981) is right in his predictions that by the year 2000, 76% of the work force will be in information/knowledge/education enterprises and other services, then the last three references will be particularly good sources of problems to prepare students for the future.

2. Most students are not explicitly taught strategies for solving problems. Some strategies are: using a model, reading information carefully, breaking the problem into manageable parts, and making a sketch. We have taught strategies to students, they have learned them, and they have improved their problem solving.

Strategies for Solving Problems

General Guidelines for Problem Solving

Guidelines from deBono. Edward deBono has formulated guidelines for good thinking and problem solving. His system has been adopted by corporate executives, taught in schools, and studied by government officials from more than a score of countries. Here are basic tools taken mostly from deBono's The Learning To-Think Coursebook.

1. Consider All Factors and Don't Limit Perceptions

A conscious effort should be made to think of everything that might be relevant for solving the problem. Suppose you're thinking about buying a new house. Consider all factors to be sure you ask all the right questions. While obvious issues such as size, cost and layout are bound to come to mind, without a deliberate effort to list every relevant factor you might overlook others. How good is TV reception? Is there a local leash law? Can the pipes be drained quickly in case of a power failure in freezing weather?

Even after using various tools of thought, you may not have found a satisfactory solution to your problem. The key to finding alternatives is to look for possibilities outside your usual thinking patterns. Edison, in searching for a light-bulb filament, tried thousands of unlikely materials including cork, fishing line and tar, before succeeding with a strip of carbonized cardboard.

2. Consequences and Sequels

One of the traits that makes us different from animals is our ability to imagine the outcome of our actions. But we can greatly improve this ability by learning to use it in a systematic way. The deBono technique is to imagine the probably outcome of a decision at four distances in the future: immediate, short term (1 to 5 years), medium term (5 to 25 years) and long term (over 25 years). By weighing the consequences of thoughts and actions, people can be less impulsive and make better decisions for themselves, based upon careful thought and not on quick emotion.

3. Aims, Goals, Objectives

An often ususued tool of better thinking is the practice of making a list of reasons for doing a particular thing. Defining goals can also help lead to creative solutions to problems. DeBono tells of a grandmother trying to knit while her yarn was being tangled by the family toddler. Exasperated, she put him in his playpen, but he howled so loudly that she had to take him out. Then she realized that her goal wasn't to pen the child, but to separate him from her yarn. So she solved the problem by leaving him out--and climbing into the playpen herself.

4. Other Points of View

Often problems involve a conflict with someone such as a friend, parent, boyfriend, or girlfriend. It is the mark of a good problem solver to be able to find a solution that will agree with the other person's viewpoint. It is particularly difficult to do when one is upset or angry. But if you can take another person's point of view at such times, then you have one of the major skills of a good problem solver.

Guidelines from Whimbey and Lochhead

An additional set of guidelines for problem solvers is given by Arthur Whimbey and Jack Lochhead in Problem Solving and Comprehension. They describe the beliefs, practices, and tendencies of good problem solvers, and also the characteristics of poor problem solvers.

1. Positive Attitude

Good problem solvers have a strong belief that academic reasoning problems can be solved through careful, persistent analysis. Poor problem solvers, by contrast, frequently express the opinion that "either you know the answer to a problem or you don't know it, and if you don't know it you might as well give up or guess."

2. Thoroughly Understanding the Data and the Problem

Good problem solvers take great care to understand the facts and the relationships in a problem fully and accurately. They are almost compulsive in checking whether their understanding of a problem is correct and complete. By contrast, poor problem solvers generally lack such an intense concern about understanding. They frequently miss a problem because they do not know exactly what it states.

3. Breaking the Problem into Parts

Good problem solvers have learned that analyzing complex problems and ideas often consists of breaking the ideas into smaller steps. They have learned to attack a problem by starting at a point where they can make some sense of it, and then proceeding from there. In contrast, poor problem solvers have not learned the approach of breaking a complex problem into subproblems--dealing first with one step and then another.

4. Avoid Guessing

Poor problem solvers tend to jump to conclusions and guess answers without going through all the steps needed to make sure that the answers are accurate. Sometimes they make intutitive judgments in the middle of a problem without checking to see whether the judgments are correct. At other times they work a problem part of the way, but then give up on reasoning and guess on an answer. Good problem solvers tend to work problems from beginning to end in small, careful steps.

The tendency for poor problem solvers to make more errors--to work too hastily and sometimes skip steps--can be traced to the three characteristics already discussed. First, poor problem solvers do not strongly believe that persistent analysis is an effective way (in fact the only way) to deal with problems. Thus their motivation to persist in working an entire problem precisely and throughly, until it is completely solved, is weak.

Second, poor problem solvers tend to be careless in their reasoning. They have not developed the habit of continuously focusing and checking on the accuracy of their conclusions. And third, they have not learned to break a problem into parts and work it step-by-step. As a result of these three characteristics, poor problem solvers have a strong tendency to make hasty responses as they work academica reasoning problems, causing errors in both simple computations and in logic.

5. Activeness in Problem Solving

The final characteristic of good problem solvers is the tendency to be more active than poor problem solvers when dealing with problem solving. Put simply, they do more things as they deal with a problem. For example, if a written description is hard to follow, good problem solvers may try to create a mental picture of the ideas in order to "see" the situation better. If a presentation is lengthy, confusing, or vague, they try to pin it down in terms of familiar

experiences and concrete examples. Furthermore they will ask themselves questions about the problem, answer the questions, and "talk to themselves" as they try to clarify their thoughts. They may try a flow-chart, brainstorm for possibilities, write on the problem, make diagrams, or use other physical aids to thinking. All in all, good problem solvers are active in many ways which help them get a clearer understanding and how to progress through them.

The Problem Solver's Knowledge Base

Robert Glasser (1984) stated that the knowledge of novice problem solvers is organized around the literal objects explicitly given in a problem statement. Experts' knowledge, on the other hand, is organized around principles and abstractions that subsume these objects. The principles are not apparent in the problem statement but derive from knowledge about the things in the problem or the subject matter associated with the problem. Knowledge of dietetics is needed to solve problems of nutrition, knowledge of auto mechanics is needed to fix a car, and so on. The problem solving difficulty of novices can be attributed largely to the inadequacies of their knowledge bases and not to limitations in their processing capabilities, such as the inability to use problem-solving strategies. "Current studies of high levels of competence support the recommendation that a significant focus for understanding expert thinking and problem solving and its development is investigation of the characteristics and influence of organized knowledge structures that are required over long periods of time" (p.99). Reuren Feuerstein (1980, p.22) sums it up very well: "It is when cognitive processes become detached from specific tasks that cognitive structures are established. These structures are of a more general nature than the learning of specific tasks and, hence, result in more adaptive behavior by the individual."

Students with a wider knowledge base are better at brainstorming for solutions across a wide range of problems. They are more able to understand and construct analogies, they make more discoveries, they see patterns, and they establish new relationships.

Some Specific Problem Solving Strategies

There are other strategies that can help people become better problem solvers. The ones to be discussed here are: thinking aloud, using the trial and error method, working backwards, finding all the possiblities, managing time, logical and critical reasoning, and gathering, recording and analyzing data. We have taught these strategies to students and have witnessed students' growth in becoming confident and skillful problem solvers.

Thinking Aloud. When using this strategy, people say aloud their thoughts while attempting to solve a problem. All mental processing, however, need not be vocalized. For example, it is not reasonable to explain the meaning of every word read for a problem. When a student is unsure of what to do, confused by an idea, or stops for some time to think about it, then some thinking aloud may be appropriate. When the strategy is used, then students should try to think aloud as much as possible. Expressing thoughts, especially at sections of a problem where difficulties or hesitancy arise, is a good way to avoid skipping steps in reasoning, jumping over important information, or being unaware of the point at which being bogged down occurred.

Thinking aloud while solving problems requires practice. At first, many students find it difficult to vocalize their thoughts as they work problems. But students do get used to expressing in words the steps they take and gain confidence in "talking out" the problem in front of the teacher and other students. We use the technique in full class settings, in small groups, and

in one-to-one discussions between student and teacher. The choice of setting depends on the nature of the problem, the students, and the teacher.

From thinking aloud, our students have learned to listen to each other, to locate breakdowns in reasoning, to learn where the stumbling point is, to realize how different people approach the same problem, and to see more than one solution to the same problem on the blackboard at the same time. Students and teachers are often amazed at how much they can learn from each other by thinking aloud.

Trial and Error

Trial and error is often underestimated as a problem solving strategy, but it can be a key strategy in the solution of some problems. Trial and error can be applied systematically by simply trying different solutions to see if they work. More often than not, however, the search can be narrowed by taking into account relevant knowledge and, by inference, reducing the number of solutions to be tried. Trial and error can also be advantageous in getting a feel for a problem. Trying out a reasonable guess, even if it does not work, can give valuable information. For example, if trying to find a decimal approximation for the square root of two, one might try 1.5 (1 is too small because 1 x 1 = 1, and 2 is too big because 2 x 2 = 4). Since 1.5 x 1.5 = 2.25, 1.5 is too big but that is valuable information because it directs the next attempt to a number between 1 and 1.5. Teachers should encourage students to make reasonable guesses at times and should specify for them the value of what was learned from the trial and error and how the error can narrow the search for a solution.

This same way of thinking about the information gained from an imperfect attempt can be applied to solutions of interpersonal problems. Suppose a father and his daughter are problem solving about the condition of her room, particularly about the dirty clothes on the floor and on the furniture. An idea to try might be a clothes hamper in her room. Both would agree that it is a trial solution to be evaluated, say, in three weeks. If the solution is not the right one, the attempt still will help to clarify the problem and suggest a better solution.

One roadblock to becoming a good problem solver is reluctance to take a risk. Many adults have been conditioned over the years to believe that there is some strategy or way to proceed in solving a problem that they "should"

have learned, and if they can't "remember how to do this kind of problem," they simply give up. Teachers are confronted with this attitude frequently when their students complain that "we haven't had this yet." Indeed, there are many specific approaches to problems that can be learned. But good problem solvers are not hampered by the conviction that there is only one way to solve a problem. They do not rely on some outside authority, but have confidence in their own ability to generate ideas. Teachers can encourage students to become self-reliant by freeing them to make reasonable guesses and to use trial and error to gain insight into a problem.

Working Backwards

Sometimes it is easier to solve a problem by working backwards rather than attacking the problem head on. Working backwards involves a change in perspective in that the new starting point was the original goal and the original starting point the new goal. Working backwards can be helpful because problems are often easier solved in one direction than another.

Working backwards has many useful applications. Suppose you are writing a position paper to your boss to convince her to accept particularly crucial idea. In thinking about how to draft the paper, you might begin by working backwards and ask yourself, "What kinds of questions would she ask me? What would be her major objections? How do I keep from offending her?" By working backwards, by starting with the goal, a more convincing paper can be written.

Finding All the Possibilities

Another important strategy for problem solving is to have a systematic way of listing all possible outcomes of some occurrence. The system must insure that all possibilities are listed and also that only those possibilities which "make sense" from the structure of the problem are listed. An example of an orderly way to list all possible ways for something to happen or all possible arrangements is show below. Thinking exercises about drawing marbles from bags are useful for developing orderly ways to exhaust all possibilities and they are generalizable to a large number of actual situations.

EXAMPLE: Suppose there are four marbles in a bag, numbered 1, 2, 3 and 4. What are all the ways to draw out the marbles if, once a marble is drawn, it is not returned to the bag? One orderly way of thinking is to actually make a list with the help of a running conversation with oneself:

"OK. Suppose I happen to take out the 1 first?" 1

"Now, I'll list all the ways if the 2 comes second. (Then later, if the 3 comes second and if the 4 comes second.) So there is 12 followed by 34 and 12 followed by 43. And there is no other way for 1 followed by 2." 1 2

1 2 3 4
1 2 4 3

1 followed by 2."

"Now, what are all the ways for 1 first and 3 second? There is 13 followed by 24 and 13 followed by 42. And there is no other way for 1 first and 3 second. 1 3

1 3 2 4
1 3 4 2

"Finally, what are all the ways for 1 first and 4 second? There is 14 followed by 23 and 14 followed by 32. And there is no other way for 1 followed by 4." 1 4

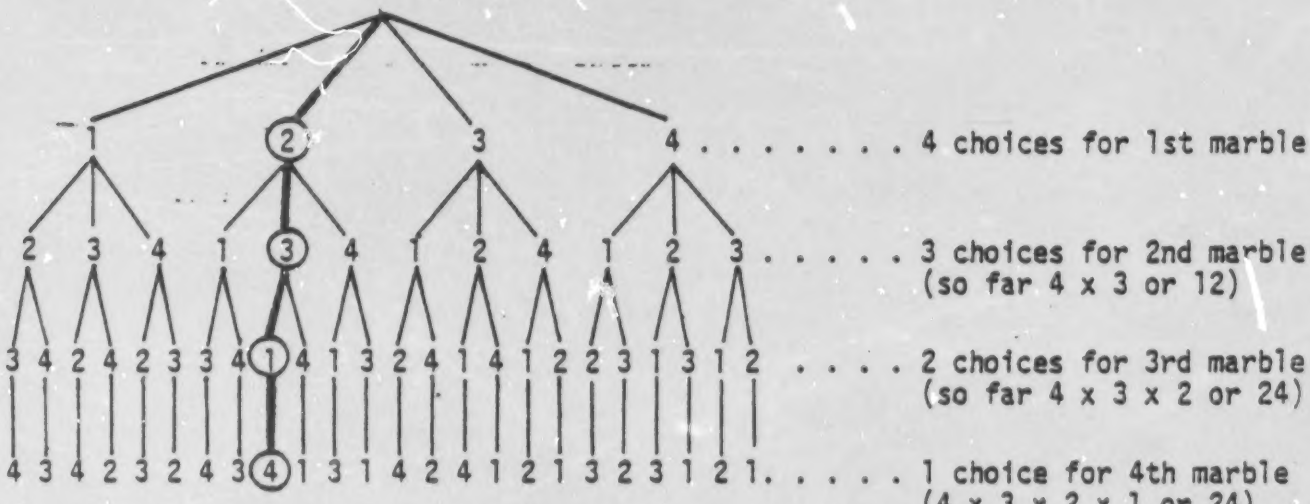
1 4 2 3
1 4 3 2

A similar conversation goes on with oneself to generate all the arrangements when 2 is drawn first, when 3 is drawn first, and when 4 is drawn first. The results:

2 1 3 4	3 1 2 4	4 1 2 3
2 1 4 3	3 1 4 2	4 1 3 2
2 3 1 4	3 2 1 4	4 2 1 3
2 3 4 1	3 2 4 1	4 2 3 1
2 4 1 3	3 4 1 2	4 3 1 2
2 4 3 1	3 4 2 1	4 3 2 1

So, there are 24 ways to draw four marbles in order if the drawn marble is replaced in the bag. Every possibility is listed and there are no more.

Another skills for finding these 24 possible ways is to draw a "tree":


1 2 3 4 . . . . . 4 choices for 1st marble
2 3 4 1 3 4 1 2 4 1 2 3 . . . . . 3 choices for 2nd marble (so far 4 x 3 or 12)
3 4 2 4 2 3 3 4 1 4 1 3 2 4 1 4 1 2 2 3 1 3 1 2 . . . . 2 choices for 3rd marble (so far 4 x 3 x 2 or 24)
4 3 4 2 3 2 4 3 4 1 3 1 4 2 4 1 2 1 3 2 3 1 2 1. . . . . 1 choice for 4th marble (4 x 3 x 2 x 1 or 24)

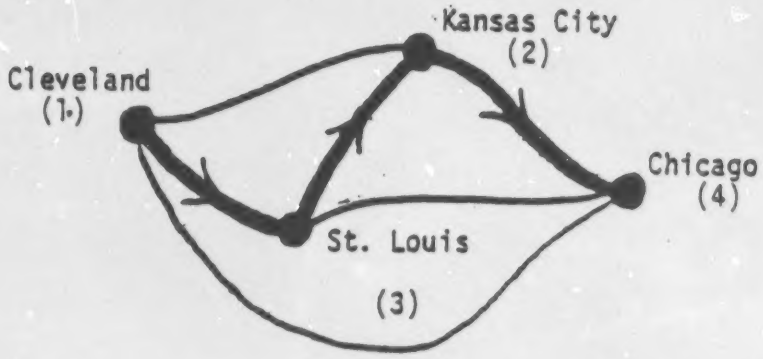
There are 24 "paths" down this "tree" and the one that is indicated above represents the combination 2 3 1 4.

The skill of drawing a tree to determine all possibilities is an important one. Suppose all the possible ways to arrange 10 digits (without replacement as in the above example) were critical information for the solution to a problem. Listing all the possibilities would be formidable and the tree would be impractical to draw. But by reducing the problem to a simpler problem (another problem solving strategy) one could realize that there is a pattern

for finding the number of combinations. The tree for the 4-digit problem makes it clear that there are 4 x 3 x 2 x 1 or 24 ways to arrange four digits. So it is logically sound to compute 10 x 9 x 8 x 7 x 6 x 5 x 4 x 3 x 2 x 1 to find the number of ways to arrange 10 digits (without replacement).

This kind of thinking is useful problem solving skill. The 4-digit problem has the same structure as figuring out, for example:

- How many different ways can 4 colors be used to paint a car if the colors for the body, the top, and two parts of the trim are arranged differently? (24 ways)
- What is the probability of drawing the "winning number" 2 1 4 3 from a box containing four chips labelled "1", "2", "3", and "4"? (1/24 or 1 of the 24 possibilities).
- How many different routes are there which reach all of 4 cities only once and which could originate in any of the four cities? (24) One such route, (1) Cleveland to (3) St. Louis to (2) Kansas City to (4) Chicago, is shown below. The illustration shows that regardless of the city of origin, any other city can be reached next, making this situation analagous to the 4-digit problem.



(leave room

Very often, the number of ways to do something or the likelihood of an event occurring is important information for solving a problem, not only in mathematics, but also in other situations.

Time Management. Time management can influence problem solving. Poor scheduling can lead to insufficient time to work through a problem to a solution, or perhaps to never even getting to the problem. An appropriate amount of time must be allocated for reflecting on the problem, for considering different ways to approach a solution, and for reviewing and critiqueing the steps used. The pressure that can result from poor scheduling can cause subpar problem solving by limiting the amount of planning time and the time needed for patient deliberation. A student's patience and perserverance is often a key to good problem solving. A necessary condition for this is good time management skills.

We have recommended to students that they keep a chart of their activities to use as a basis for managing their time better. Time priorities often have to be set each day and a chart or list can help. Some students do not manage their time well enough to acquire an essential piece of knowledge, get to the library, or talk to someone who can help them. Allocating specific blocks of time to specific tasks according to their importance and the time they require is a useful skill. Systematic reflection on one's use of time and on how much is lost if it is used inefficiently can lead students to modify their own behavior.

Logical and Critical Reasoning

A lack of logical and critical reasoning skills hinders students' progress in becoming adept problem solvers. The more we listen to them talk aloud about their problem solving, check their papers, and observe their activities,

the more we are impressed with the extent of their deficiencies in logical and critical reasoning.

One of the major problems students have is dealing with ambiguities in the English language. For example, consider the real-life story of a famous mathematician who had to take a driving examination. He had memorized many statements from a booklet, including the following:

It is illegal to park within 15 feet of a fire hydrant.

As part of the test, he was given some "true-false" questions, one of which was:

It is illegal to part within 9 feet of a fire hydrant. False __ True __

The mathematician checked "True" on the grounds that if the statement he had memorized was true, then the question in the test was true. The examiner, however, claimed that the correct response was "False," since the statement in the booklet explicitly mentioned "15 feet" and not "9 feet."

Next consider the phrase from the song "Home on the Range":

"...and the skies are not cloudy all day."

What on earth does it mean? Does it mean that all day long there is <u>never</u> a cloud in the sky? Does it mean that the skies are not cloudy <u>all</u> day long--there is usually a moment, about 2:15 p.m. or so, when a bit of sunshine and blue sky breaks through? Just what does it mean? Does it mean that, on the average, the skies are much less cloudy than they were back East? Who knows?

As another example, consider the two statements:

a) A Swede invented dynamite.

b) A Swede is a European

The meaning of the indefinite article "A" before "Swede" in these two statements is quite different: in (a) it means <u>one</u>; in (b) it means <u>every</u>.

The phrase "...and the clouds are not cloudy all day" was, of course,

never intended to be a precise statement about anything. It was intended merely to evoke an image of the clear, bright, sunny West. But, even when one tries to be precise, the ambiguities of English can present problems for students.

As an illustration of the role of logical reasoning in problem solving, the following table was given to a class of high school seniors.

Resting Systolic Blood Pressures Found in 20 Patients

Morning Patients (Doctor I)				Afternoon Patients (Doctor II)			
Patient Number	Sex	Age	Pressure (mm Hg)	Patient Number	Sex	Age	Pressure (mm Hg)
1	F	25	120	11	F	22	122
2	M	42	150	12	F	47	151
3	F	22	120	13	M	21	118
4	F	35	135	14	F	40	133
5	F	45	145	15	F	44	141
6	F	31	125	16	F	19	126
7	F	21	120	17	F	25	120
8	F	27	130	18	M	22	128
9	F	32	130	19	F	39	133
10	F	20	120	20	F	21	123

Accompanying the table was the statement:

> If a patient had both a morning and an afternoon blood pressure reading taken, then the afternoon reading would be higher.

Students were to select one of the following as their answer:

(A) The statement is supported by the information given.

(B) The statement is contradicted by the information given.

(C) The statement is neither supported nor contradicted by the information given.

Every student in the class of 12 pupils marked "B" because they said that no patient had a morning and afternoon reading. This is an incorrect interpretation of the hypothetical "If...then..." statement. The correct answer is "C" since no consistent pattern exists of higher readings in the afternoon.

This same class also declared these next two open sentences to be equivalent:

(1) $x(x-3)=0$

(2) $x=0$ and $x=3$

They are not equivalent. However, the two sentences would be equivalent if the work "and" were replaced by "or".

Students need to be given more practice and guidance in dealing with the logic of problems with a particular emphasis on teachers giving them many sound and appropriate problems to work and listening to them reason aloud. We strongly recommend An Introduction to Logic by Exner and Kaufman (1978) from CEMREL, Inc., St. Louis, Missouri.

Critical reasoning is another area of student deficiencies. Students often lack skills to assess expressed ideas, beliefs and statements which one encounters daily through the media and through remarks made by people in the form of opinions, reports, rumors, etc. There is quite a well-organized body of knowledge on critical reasoning.

The process of critical inquiry is an impartial one. Judgments and evaluations are delayed until the data is in. Observations, people's opinions, collected information, etc., should all be in before decisions are made. The process is to be objective, avoiding preconceived versions of the results. It should be open enough to invite further inquiry if people are not satisfied and problems are not solved. Also, in critical inquiry people's feelings are often involved. Respect for people's personal dignity must be remembered when people are the objects of the inquiry.

Another important part of critical inquiry is evaluating the assumptions being made during the inquiry. If assumptions are not clearly in mind, then invalid conclusions can be drawn, inappropriate decisions made, or people's feelings hurt. An example from Joan Hearn's (1982) More Life Skills is:

> Willie Jones is a fifteen year old, Grade 10 student who spent Saturday night breaking windows at his high school.
>
> His mother's assumption is that his is a crazy, mixed up kid.
>
> His father's assumption is that boys will be boys.
>
> His principal's assumption is that there are too many boys like Willie about and that the school is better off without them.
>
> The police's assumptions are that public property must be protected and wrong doers must be discouraged.

It is clear that if Willie's mother were to discuss Willie's activities with his high school principal, neither of them is going to get anywhere because they are arguing from different assumptions.

People can improve their critical reasoning skills. And it is evident from our experience that there is no substitute for practice. Students must be given good situations, problems, and simulations from which to develop and sharpen their skills. An excellent source is Joan Hearn's (1982) More Life Skills.

Gathering, Recording and Analyzing Data

The first step in the Problem Solving model is to understand the problem. When full information is presented to a student, understanding the problem involves careful reading, eliminating extraneous information, and for some problems, drawing a sketch or a diagram or organizing given data in a table. These are the usual kinds of problems students are given in school. Unfortunately, most problems encountered in one's life (at work, at home, or socially) are not so "neat." Crucial or helpful information is often missing and the problem solver must have skills not only for obtaining necessary information, but also for recognizing what information is needed. Some example of such problems follow.

- How can productivity be increased in Plant A?
- How can the absentee rate be reduced?
- What is the least expensive way to get Job X done, considering labor costs, cost of materials and employee morale?
- How do I get my car started so I can get to work on time this morning?
- What steps can I take to effect a behavior change in Person Y?
- To cut costs and maintain sales volume, where can money best be saved in the production of Product X, packaging or advertising?
- What is the best solution for a problem involving a desagreement between labor and management?
- How can the quality of on-the-job training be improved to teach skills more efficiently?
- What are the important variables for increasing morale?
- How can I plan my finances to reserve X amount of money per month for investments?

Data-gathering can occur on many levels. In some cases, understructured observation is useful. For example, simply watching a production line for an hour could help a person to generate ideas for a more structured efficiency study. Or a task-oriented

group could be observed for clues about group discord. More analytical data-gathering involves the use of checklist or coding of events or behaviors. Once data is collected, a second skills is to summarize the information in a meaningful form. If the information is quantitative, data from a checklist can be recorded in a variety of kinds of graphs, tables, or figures. Non-quantitative observations can be categorized or written up as a case study. The skill of selecting a way to represent data interacts with a third skill: analyzing observational results.

General Motors recognizes that data-gathering is often critical for problem-solving. The manual they use for training employees to conduct Employee Participation Groups includes the following data-gathering skills:

1. Making Check Lists. The following examples from the GM manual show how information can be organized about two different aspects of possible causes of a parts shortage (e.g., type of part and number of shortages by month). Direct observations are recorded as they occur.

Type Of Part	Number Of Shortages By Month												
	J	F	M	A	M	J	J	A	S	O	N	D	Total
001	✓												
002	✓✓												
003													
004													
005													
006													
Other													
Unknown													
Total													

Type Of Part	Number Of Shortages By Shift				
	1	2	3	Other	Total
001	✓				
002		✓	✓		
003					
004					
005					
006					
Other					
Unknown					
Total					

Type Of Part	Length Of Shortage				
	1 Hr.	1 Wk.	1 Mo.	Other	Total
001		✓			
002	✓		✓		
003					
004					
005					
006					
Other					
Unknown					
Total					

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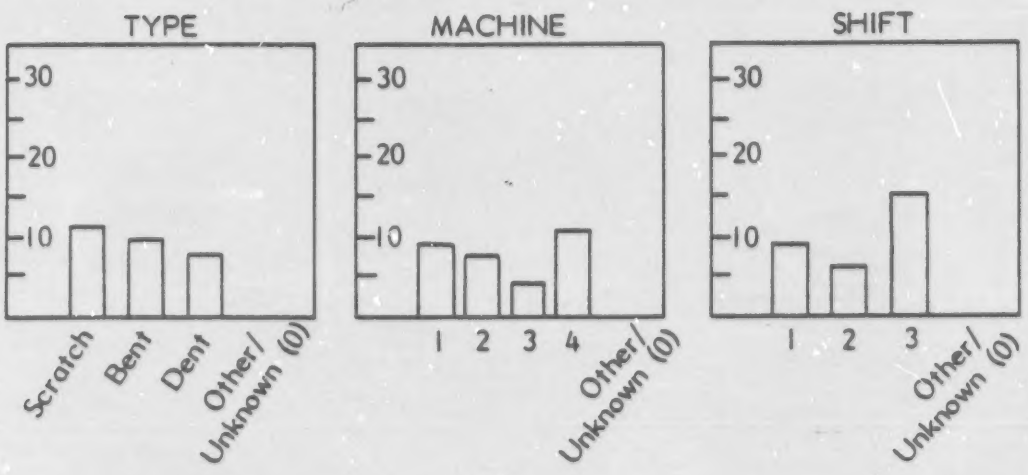
2. Making Charts. Information from check lists can be recorded in charts which help the problem-solver to analyze the problem to be solved.

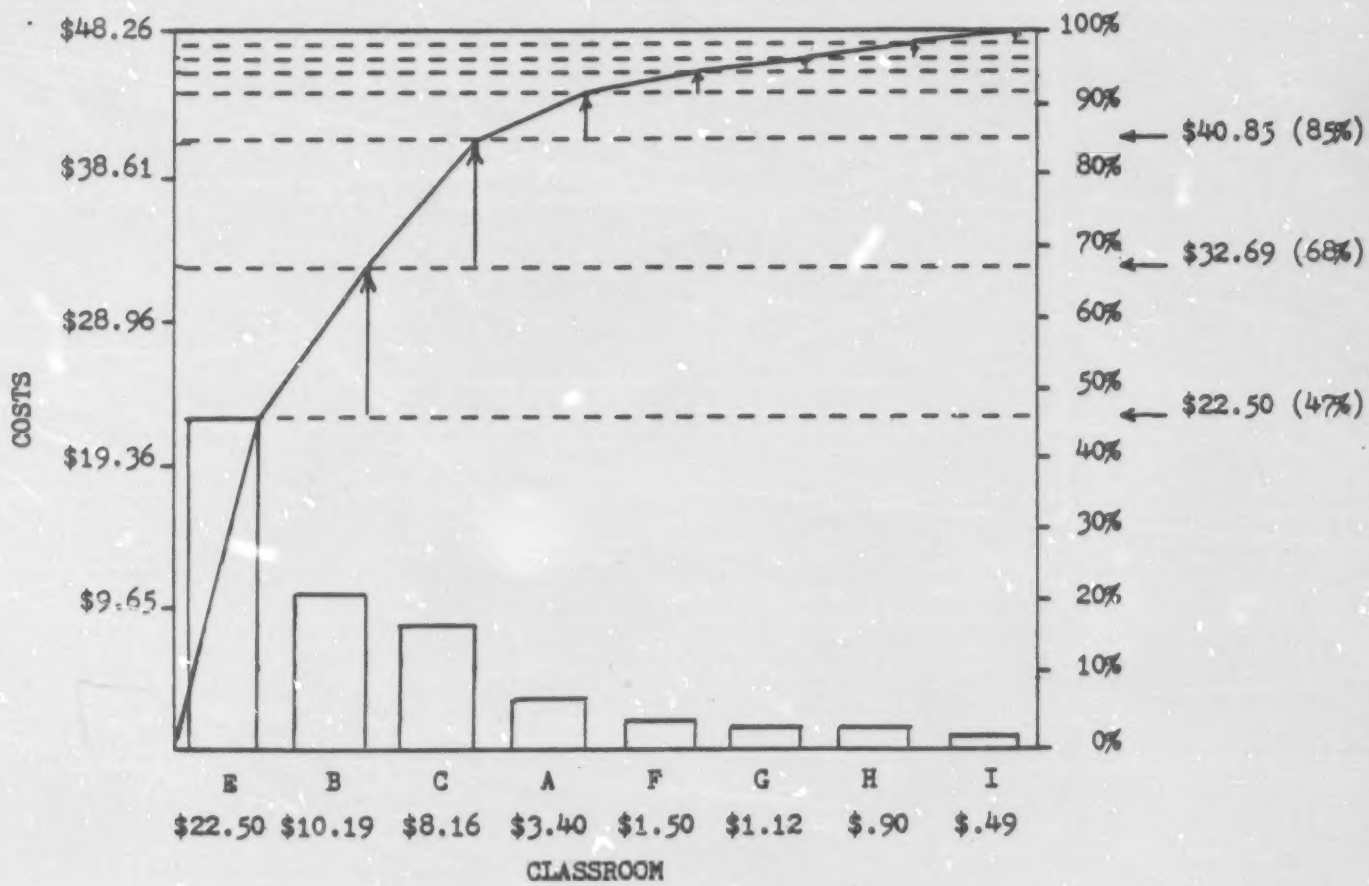
An example:

Type Of Reject	Machine				Total
	1	2	3	4	
Scratch	4	2	1	5	12
Bent	3	1	2	4	10
Dented	1	4	1	2	8
Other/Unknown	0	0	0	0	0
Total	8	7	4	11	30

A second kind of chart is a bar graph. The following graphs indicate that possible causes of rejects to consider first might be (1) something making scratches (12 of the 30 rejects); (2) involved with the 4th machine (11 of the 30 rejects); (3) on the 3rd shift (15 of the 30 rejects).



A third kind of chart is a Pareto chart. Pareto charts organize vital information and data in a cummulative way. In the following example from Lloyd and Rehg (1983), the weekly cost of supplies for eight classrooms has been converted into percentages which have been depicted in a bar graph with the percentages in descending order. The solid line illustrates cumulative percentages. In this example, the graph shows that classrooms E and B are responsible for 68 percent of the total expenditure. One option from this data is to conclude that the other classroom expenditures are "trivial" factors and attention should be focused on the costs for schools E and B.



Social and interpersonal problem solving can also require data-gathering. Much of this must be done via observation of people and their interactions. In conflicts between two people, the needs of both people must be known and good listening skills (to be outlined in a later section) can provide much of the necessary data. For example, if an employee gradually becomes less productive and less cooperative, a supervisor's listening skills might reveal problems ranging from poor health to financial problems to unsatisfactory working conditions. Such information-gathering is critical for interpersonal problem solving.

Many interpersonal problems involve needs, preferences, or values of groups of people. Useful information can be collected via interest surveys, evaluation forms, or other questionnaires. One of the most effective ways to improve the quality of training programs is to conduct frequent anonymous evaluations by participants. Tallies of responses to objective items often reveal patterns of possible causes of problems. For example, ratings for the instructor's rapport with the class might be low while ratings for instructional materials are high. Open-ended questions are extremely useful and usually give additional additional relevant information.

Objective observation of group dynamics is often the key to solving problems involving group cohesiveness and group productivity. In most groups, people assume roles (leader, follower, antagonist, peace-maker, clown, etc.). Observation of interactions among members of a group is useful information for a group facilitator.

Good and Brophy (1978) give many examples of instruments for gathering information about classroom dynamics and teacher behavior. The following form, for example, can be used to determine whether a teacher is giving appropriate feedback to students about the adequacy of their responses in discussion and recitation sessions.

TEACHER FEEDBACK WHEN STUDENT FAILS TO ANSWER CORRECTLY

DIRECTIONS: When a student is unable to answer a question or gives answers incorrectly, code as many categories as apply to the teacher's feedback responses.

BEHAVIOR CATEGORIES

1. Criticizes
2. Says "No," "That's not right," ect.
3. No feedback--goes on to something else
4. Ambiguous--doesn't indicate whether or not answer is acceptable
5. Asks a student or the class whether answer is correct
6. Asks someone else to answer the question
7. Repeats question to same student, prompts ("Well?" "Do you know?" etc.)
8. Gives a clue or rephrases question to make it easier
9. Asks same student an entirely new question
10. Answers question for the student
11. Answers question and also gives explanation or rationale for answer
12. Gives explanation or rationale for why student's answer was not correct
13. Praises student for good attempt or guess
14. Other (specify)

1.	____	13.	____
2.	____	14.	____
3.	____	15.	____
4.	____	16.	____
5.	____	17.	____
6.	____	18.	____
7.	____	19.	____
8.	____	20.	____
9.	____	21.	____
10.	____	22.	____
11.	____	23.	____
12.	____	24.	____

If instruction in problem solving is to be transferable to real-life problems, students must learn to gather relevant information and they must be armed with tools for recording and analyzing their observations.

THE FIVE STEP MODEL EXTENDED FOR PROBLEM SOLVING

The Five Step Model has been developed as an aide for students in solving problems. It is extended here to show how many useful strategies can be embedded within the model.

Extended Model

1. Understand the problem

   - o What are the essential data?
   - o Is there enough information to solve the problem?
   - o Would a figure or sketch help? Maybe introduce symbols or other variables.
   - o Separate the problem into manageable parts, if needed. Write down each part.
   - o Can the problem be restated in a different way to help understand it?

2. Brainstorm for Possible Solution Strategies

   - o Generate a lot of ideas. Don't judge them, just write them down.
   - o Has a problem like it been solved before?
   - o Would working a related problem be useful?
   - o If there were some particular additional information, could the problem be solved? Where would the information be obtained?

3. Choose a Tentative Solution Strategy

   - o Remember, the strategy may not work and the process may have to be started over.
   - o For "people" problems, consequences associated with carrying out tentative strategies must be carefully weighed.
   - o Also, if people are working out an interpersonal problem, then the tentative strategy will likely be a compromise: No one is likely to get everything they want.

4. Carry Out the Tentative Solution Strategy

   o Check each step as the plan in carried out. Check that each step is OK. Is each step correct or valid?

   o Are there probably places for errors, mistakes, or faulty reasoning? Where are they?

   o Would it be useful to have someone else go over your steps?

   o For implementing solutions to "people" problems, decide "Who does What, When." Maybe write it down.

5. Learn

   o Check the result if possible. Is the judgment sound? Does it have a reasonable chance of solving the problem?

   o What are the implications or consequences of the solution?

   o Could the problem be worked another way? Perhaps look at other people's solutions and hear what they have to say.

   o If appropriate, evaluate the effectiveness of the solution.

   o Have enough problems like this one been worked to begin to generalize to a plan for solving similar problems?

   o Does this solved problem open up new relationships that hadn't been thought of before? Think about it!

   o What are your strengths as a problem solver? Your weaknesses?

   o Are you getting involved in solving problems? Are you doing the work or is someone else? Your involvement is essential.

Higher Order Problem Solving Skills

Since its inception in 1969, the National Assessment of Educational Progress (NAEP) has surveyed the knowledge, skills, and attitudes of over one million students. The Education Commission of States, which collects this data, reported that "today's minimum skills are demonstrated successfully by a majority of students. Higher order skills, however, are achieved only by a minority of 17-year-olds, and this proportion declined over the last decade. If this trend continues, as many as two million students may graduate in 1990 without the skills necessary for employment in tomorrow's marketplace" (Education Commission of the States, 1982, p. 2). They further noted that:

> The "basics" of tomorrow are the skills considered to be of a higher level today. These skills include:
>
> - o Evaluation and analysis skills
> - o Critical thinking
> - o Problem-solving strategies (including mathematical problem-solving)
> - o Organization and reference skills
> - o Synthesis
> - o Application
> - o Creativity
> - o Decision-making given complete information
> - o Communications skills through a variety of modes (p. 6)

A survey of 123 school systems (Henry & Raymond, 1982) found that the basic skill of "reasoning" had the smallest percentage of school systems evaluating students as having superior preparation. Sixteen percent of the schools acknowledged that "the majority of work force-bound students were inadequately prepared to reason through complex problems and decisions" (p. 21).

Archie E. Lapointe (1984) Executive Director of the Center for the Assessment of Education Progress, drew the following conclusion from NAEP findings.

> Closer examination of the data reveals that poorly developed problem solving skills hinder students' performance in mathematics. Indeed, weaknesses exist in the so-called higher-order skills in general. Most students do well with literal comprehension but lack the skills of inference,

> analysis, and interpretation. Today's definition of functional literacy calls for these higher-order skills more than ever before, even as students' mastery of them is seemingly on the decline. Clearly, a renewed focus on these skills is needed (p. 666).

As students attempt to solve more and more complex problems, the need for them to acquire higher-order problem solving skills increases. For General Motors, some of these skills are problem analysis, decision-making, and planning. Some higher-order skills listed by Piaget are hypothetical thinking, observing and discovering patterns, establishing relationships, making generalizations, and sophistication with combinatorial and probabilistic thinking. Bloom's (1956) hierarchy of cognitive skills begins with knowledge of facts and extends to higher-order skills.

Level 1: Knowledge. The ability to recall specific facts, methods, or procedures: terminology, facts, rules, trends, classification schemes, criteria, methodology, principles, generalizations, theories, structures. This level involves little more than retrieving stored information.

Level 2: Comprehension. The ability to make use of what is being communicated: to translate or put information in another form (restate an idea, interpret a diagram, summarize, draw a picture); to interpret or reorder ideas and comprehend inter-relationships; to extrapolate or go beyond the given data (drawing conclusions, theorizing, predicting). This level involves understanding ideas.

Level 3: Application. The ability to apply knowledge and principles to actual situations: generalizing to another situation. This level involves putting into action knowledge which from Level 2 has been understood.

Level 4: Analysis. The ability to classify or break material down into its components, to understand the relationships between the components, and to recognize the principle that organizes the structure or the system: to compare and contrast, to distinguish between fact and opinion, to recognize

extraneous information, to recognize unstated assumptions, to compare theories. This level involves a kind of logical thinking similar to Piaget's formal operations.

Level 5: Synthesis. The ability to bring together ideas and knowledge from many sources to form new ideas, methods, or procedures: unique communication, a plan, a set of operations, a strategy. This level involves creative or original thinking.

Level 6: Evaluation. The ability to make quantitative and qualitative judgments: to weigh, to examine, to analyze, to use criteria, to recognize the best of several reasonably good answers or solutions. This level requires the abilities of the first five levels and is crucial for substantive problem solving.

Although Bloom et. al. prepared their widely accepted taxonomy in 1956 as a guide for developing and evaluating educational objectives, actual classroom instruction has generally focused on Level 1 and Level 2 objectives. Bloom (1984) observed:

> . . . teachers in the United States typically make use of textbooks that rarely pose real problems. These textbooks emphasize specific content to be remembered and give students little opportunity to discover underlying concepts and principles and even less opportunity to attack real problems in the environments in which they live. The teacher-made tests (and standardized tests) are largely tests of remembered information. After the sale of over one million copies of The Taxonomy of Educational Objectives--Cognitive Domain (1956) and over a quarter of a century of the use of this domain in preservice and in-service teacher training, it is estimated that over 90% of test questions that U.S. public school students are now expected to answer deal with little more than information. Our instructional material, our classroom teaching methods, and our testing methods rarely rise above the lowest category of the Taxonomy--knowledge (p. 13).

There is no better context within which to develop higher-order skills than in the context of problem solving. A bonus is that the cognitive levels of knowledge and understanding can also be developed via problem solving. The

National Council of Teachers of Mathematics in its Agenda for Action--Recommendations for the 80's (1980) had as its number one recommendation that mathematical content for K-12 be taught primarily in a problem-solving context.

Simulations

In simulations, students are actively involved. The student assumes an active role as a problem solver and often controls decisions and consequences that are a part of most problem solving situations. For example, in the simulation Life-Career (published by Western Publishing Co.), students must make decisions and solve problems for a fictitious person as the person deals with work, marriage, and education. Players plan time and activities relative to school, studying, job, leisure time, and family. The game generates a universe of simulated experience that students can compare with the real world; that is, they can compare the experiences in the game to what they believe true about their own world. Sarane Boocock (1968) found that the Life Career simulation increased students' facutal knowledge about careers; established new relationships for students on how jobs, school, and family can be very interdependent; helped students learn that there is a causal relationship between their behavior and the outcome of events; and increased student confidence in their decision making and problem solving abilities.

The World Future Society published a directory of information resources which includes descriptions and references for 45 simulation games (Cornish, 1979, pp. 627-638). Some other resources:

- Simulation Games for the Social Studies Classroom by William A. Nesbitt (1971), Foreign Policy Association, Glenview, IL.
- Construction and Use of Written Simulations by Christine McGuire, Lawrence Solomon, and Philip Bashook (1976), The Psychological Corporation.
- Simulation Games in Learning by Sarane Boocock and E. O. Schild (1968), Sage Publications, Beverly Hills, CA.

Good simulations require most of the essential moves of successful problem solvers: gathering data, selecting alternatives, conducting analyses, synthesizing, generalizing, making decisions, planning, and taking action. According to William A. Nesbitt (1971), simulations teach students to think critically, examine alternative strategies, and to critique their own decisions and behaviors. Simulations provide an opportunity for students to solve substantive problems and to gain confidence in their abilities to tackle problems, wrestle with them, and by progressing a bit at a time, eventually solve them.

Interpersonal Skills for Being Effective With Individuals and In Groups

Interpersonal skills are critical for problem solving, and they have been identified as highly desirable by employers. A very recent study, Perspectives on Vocational Education (Chicago United, 1984), found that 94% of 995 employers cited the ability to work with others as the interpersonal skill they most wanted in their workers. One of the conclusions from a survey of 593 secondary vocational training teachers in 32 vocational training program areas (Greenan, 1983) was that "all interpersonal relations skills are very important for success and highly generalizable across all program areas and programs" (p.57).

Considering the importance placed on interpersonal skills by representatives of business and industry and by vocational educators, they should be part of a pretechnical curriculum. The following outline gives a listing of specific skills which are applicable in most interpersonal settings -- at home, at work, and particularly in task-oriented problem solving sessions.

Summary of Interpersonal Skills

I. Awareness of self and others
   - A. Values
   - B. Needs
   - C. Feelings

II. Recognizing problem ownership (Who is upset?)
   - A. Identifying self as being upset
   - B. Identifying other person as being upset

III. Selecting appropriate skills according to problem ownership
   - A. Assertive statements when problem owned by self
   - B. Listening skills when problem owned by other person

IV. Recognizing Roadblocks to Communication when someone owns a problem
   - A. Directive Responses
     1. Ordering, commanding, directing
     2. Warning, threatening
   - B. Solution Responses (advising, offering solutions or suggestions)
   - C. Persuasive Responses
     1. Moralizing, preaching, giving "shoulds and oughts"
     2. Teaching, lecturing, giving logical arguments
     3. Reassuring, sympathizing, consoling, supporting

D. Evaluative Responses

1. Judging, criticizing, disagreeing, blaming

2. Name-calling, stereotyping, labeling, ridiculing

3. Praising, agreeing, giving positive evaluations

4. Interpreting, analyzing, diagnosing

E. Avoidance Responses

1. Withdrawing, distracting, being sarcastic, humoring, diverting

2. Emphasizing one's own needs

F. Questioning responses (Probing, interrogating, cross-examining

G. Interrupting

V. Avoiding Roadblocks to Communication

VI. Listening

A. Encouraging the other person to talk

1. Silence

2. Nonverbal encouragement

3. Verbal encouragement

B. Responding by reflecting meaning

1. Paraphrasing

2. Clarifying, confirming

C. Responding by reflecting meaning and feelings -- Active Listening

D. Applying Active Listening

1. Dealing with anger

2. Facilitating problem solving

3. Support and rapport

VII. Assertive statements

A. Distinguishing between aggressive and assertive statements

B. Giving I-Messages

Problem Solving in Groups

Problem solving in groups is now emerging as an important part of the work world for all levels of employees, not just managers (Pratzner & Russell, 1984). Many companies are involving workers in diagnosing problems and implementing effective solutions. These organizations have implemented programs called "Quality Circles Programs," of which one important element is the Quality Control Circle. Very briefly, Quality Control Circles have these things in common. Size: preferably five to ten members. Volunteerism: freedom of choice to join. Meetings: one hour weekly, with exceptions. Skills: brainstorming, cause and effect analysis, data collection, effective planning.

Japanese industrialists have been using Quality Control Circles since 1960. As many as 11 million workers are involved in Quality Circle movements throughout Japan, and idustries in all of the world's industrialized countries have shown interest in implementing the process. The Lockheed Company's Missile and Space Division was the first United States organization to put the concept into action in 1974 and a $500,000 investment in the program resulted in an estimated savings of $3 million (Lloyd & Rehg, 1983).

The National Center for Research in Vocational Education listed organizations in the public sector which have implemented employee participation groups (Lloyd & Rehg, 1983). Among these are the U.S. Air Force, the U.S. Army, the U.S. Navy, and the Federal Aviation Administration. Also listed were 162 organizations in the private sector. Among these are such major companies as Bendix Corporation, Firestone, G. E. Major Appliances, General Foods, General Motors, Hewlett Packard, Hughes Aircraft, J. C. Penney, McGraw-Edison, Polaroid, 3M, Union Carbide, Uriroyal, and Westinghouse.

Not only are Quality Control Circles advantageous for productivity in business and industry, they are very effective for problem solving in any organization. Lloyd and Rehg (1983) gave an example of effective use of Quality Control Circles by school districts.

> . . . a midwestern schhol district has used the QC process to solve problems that results from declining enrollments and escalating costs (Rehg, 1982). Ten quality circles made up of administrators, faculty, staff, and citizens met to develop solutions which were then compiled and distributed to the ten groups. Consensus was reached, and the proposed solution was then presented to the public for review. The school board adopted the solution essentially as proposed by the quality circles. No complaints were received nor were any grievances filed despite the facts that some teachers were reassigned and some terminated, and that some schools were closed. In contrast, the school board, in an adjoining district facing a similar problem, made a unilateral decision to close certain schools. In response, a citizen's group filed a lawsuit in an attempt to block the closing.

Pratzner and Russell (1984) have delineated the skills, knowledge, and abilities needed for high-involvement participative work setting (pp. 12-13). Under the skill are Group Problem Solving they list eight sub-categories: Interpersonal Skills, Group Process Skills, Problem-Solving Skills, Decision Making, Planning, Communication and Thinking/Reasoning. The specific skills for two of these categories are given below.

Interpersonal Skills	Communication
o Self-directed	o With individuals
o Flexible	o With groups
o Assertive	o Presentation skills
o Open	o Verbal skills
o Curious to learn	o Writing skills
o Able to share/teach	o Listening skills
o Responsive	
o Understanding of behavior	

The General Motors Employee Participation Groups Manual (1980) is used to train employees to be effective group members. Many of the skills the employees learn are interpersonal skills. Some examples:

Involving Others. You may notice some people getting quiet during a meeting. They may have information or ideas but may be reluctant to break into the discussion. You can "invite" them in. Example: "John, we haven't heard from you yet. What do you think?"

Give Credit--Avoid "Put-Downs". If you borrow another's idea or add to it, give them credit for the basic idea. If you don't like another's idea, avoid criticizing the person. Example: "Mary's idea of using the scrap is a possibility. I like it better than not using the scrap." (Not using the scrap was Paul's idea.)

It is not sufficient for successful group problem solving for a person to be adept at problem solving strategies without also having good interpersonal skills. Unlike individual problem solving, group solution strategies are usually arrived at through processes which require listening, empathy, cooperation, and concern for everyone's needs.

The Five-Step Model is highly adaptable to group problem solving, whether mutual problems exist for only two individuals or a group. Some problems center around Conflict of Needs. That is, the needs of one or more persons are not being met, and a change in the behavior of the other person or persons is necessary to solve the problem. In such situations, the specific interpersonal skills described earlier are necessary, particularly at the first step, as shown below.

Five Step Model for Solving Problems Resulting from a Conflict of Needs

1. Understand the Problem

   - o One person initiates the process by giving an I-message.
   - o Often, the other persons will be defensive or will unveil their own related problems, so the first person must reflect meaning or actively listen in order for the real problem(s) to be identified. Avoiding roadblocks is critical at this point, particularly if the sharing becomes emotional.
   - o Once the problem is clarified, it should be summarized to be certain that there is agreement on what the problem is.

2. Brainstorm for Possible Solutions

   - o Suggestions are not to be evaluated, and a skillful person encourages others to contribute ideas.
   - o Self-knowledge is important for resisting tendencies to interrupt, to put other people's ideas down, or not to be open to new ideas.

3. Choose a Tentative Solution

   - o Although compromise is sometimes necessary at this stage, the needs of both or all people must be met as best as possible. Assertive statements are important if one feels that a solution is not good for all the people involved, particularly for oneself.

4. Carry Out the Tentative Strategy

   - o It is important to decide "Who, does What, When."
   - o A very specific time should be sent for evaluting the solution, which should be considered a trial solution, perhaps the first of several attempts to meet everyone's needs.

5. Learn

   - o As new procedures, routine, or behaviors are attempted, look for opportunities to increase self-knowledge. If the solution is not working, this is the time to look more closely at your real needs. Perhaps the problem, as you saw it, was not the real problem for you. Maybe you need to change what you are doing. Maybe the environment needs to be changed.
   - o Evaluate the effectiveness of the solution. The process might need to be repeated, from steps 1 through 5.

Thomas Gordon (1974) calls this process the "No Lose" problem solving method. In most interpersonal problem solving one person "wins" and the other "loses". Examples are: authoritarian classrooms where teachers "win" and students "lose" or permissive classrooms where students "win" and teachers "lose." Analagous situations occur in business and industry when management and labor become involved in power struggles. The objective of the Five Step Model is to resolve conflicts or to solve problems so that everyone gets some of their needs met.

This kind of process is used in business and industry when Quality Control Circles engage in group problem solving and the results have been impressive. Lloyd and Rehg (1983) gave examples of the outcomes of some of these group efforts.

- A Quality Control committee suggested a procedure which was initiated by the Purchasing Department at Westinghouse Electronics Systems Center in Baltimore, Maryland. By returning overshipments to vendors at their own expense, an estimated $636,000 was saved.
- Management of a General Motors plant in Tarrytown, New York was considering closing the plant down because of high absenteeism and poor product quality. The number of outstanding employee grievances against management totalled two thousand. Since Quality Circles began to hold meetings to discuss complaints and ideas for boosting efficiency, the number of outstanding grievances has dropped to thirty, and absenteeism has been reduced to 2.5 percent.
- At the Lockheed Company, a Quality Circle developed a method to mold a plastic part assembly in two instead of five steps. The redesigned assembly is lighter and stronger than its predecessor, and has resulted in an estimated savings of $160,000 over the life of the contract. Since 1974, Lockheed's savings from its Quality Control program are estimated at almost $3 million, six times the cost of operating the program.

The Need for Interpersonal Skills for Negotiating

Whether between individuals or in groups, interpersonal skills are central to successful negotiation as described by Fisher and Ury in their 1983 best-seller, Getting to Yes: Negotiating Agreement Without Giving In. Negotiations occur in everyday life, as when a person returns a defective product and needs a settlement or when price differences must be resolved. In more formal negotiating processes, individuals represent constituencies and negotiating sessions are sometimes hardhitting encounters, even to the point of using "dirty tricks." Fisher and Ury, however, advocate an approach that consists of skillful interpersonal interactions combined with assertive skills. Some of the skills they mention are awareness of one's fellings, active listening, and I-messages.

". . . human beings . . . are creatures of strong emotions who often have radically different perceptions and have difficulty communicating clearly. Emotions typically become entangled with the objective merits of the problem . . . Figuratively if not literally, the participants should come to see themselves as working side by side, attacking the problem, not each other (p.11)."

Conclusion

It is clear that the American workplace is placing increasing importance on employee problem solving and that interpersonal skills are needed to be effective in problem solving groups. In addition, most citizens are involved in several groups in their daily lives-- in classes they take, in PTA's, in social groups, in church groups-- and the quality of their participation would be enhanced by being more skilled interpersonally. That is sufficient evidence to consider interpersonal skills "basic" and to seriously consider where and how they should be taught in the pre-technical curriculum.

There is a need for a formal curriculum for problem solving skills. Skills must be studied, analyzed, and practiced. At the same time, teachers should acquire these skills themselves so that they will be effective models for students. Teachers must be prepared to facilitate problem solving whenever the need arises. These are the learning experiences which students will remember above all others. Active involvement in actual problem solving is invaluable, and this should occur at <u>all</u> grade levels.

Implementation

The design for implementation of a pretechnical curriculum presented in this section synthesizes ideas of Dyrenfurth (1984) on technological literacy of Levin and Rumberger (1983) on recurrent education, of Silberman (1983) on the goals of vocational education, and Pratzner's (1984) work on socio-technical literacy. The design is based on the following assumptions:

- Employees will work in environments influenced by change and technological innovations.
- The structure of the labor market will require differing degrees of training. Periodic retraining will be a significant part of the work experience, regardless of an individual's position within the structure.
- Education must give individuals the skills needed at entry level positions and for undertaking education and training as needed to progress occupationally.
- Employees will have increased opportunities to work in high-involvement industries, which will increase their opportunities to participate in problem solving and in group consensus decision making.

The responsibility for providing a pretechnical as well as a technical education is the shared responsibility of both subject matter and vocational education teachers. Vocational educators are primarily responsible for cooperating with subject matter teachers to insure that appropriate and up-to-date applications are being taught. They are also primarily responsible for teaching entry level job skills and for preparing students to deal with their work lives.

The responsibilities for vocational educators are further extended by the fact that individuals enter the labor force at different times in the educational sequence. For instance, they must provide for drop-outs who have not achieved

a minimal level of technological literacy and for enrolled students who are seeking first jobs with minimal level job skills.

The skill to be implemented are depicted in Figure 1 which displays who does what when.

Figure 1

Implementation Structure

Generalizable Skills	Transition Skills	Problem Solving Skills
Reasoning	Change in Environment	Cooperative Group Skills
Communication	Change in Relationships	Interpersonal Skills
Mathematical	Change in Self	Information Related Skills
Interpersonal	Stress, Loss, Grief	Task Related Skills
Attitudinal	Decision Making	Understanding Human Behavior
Technological		

PRETECHNICAL EDUCATION (7-12)		TECHNICAL EDUCATION
EDUCATIONAL LEVEL: 7-10	EDUCATIONAL LEVEL: 11-12	EDUCATIONAL LEVEL: 13 and beyond
CONTENT: Generalizable skills Transition Skills Problem Solving Skills	CONTENT: Generalizable Skills Tranisition Skills Problem Solving Skills Entry Level Job Skills High Tech Skills (The emphasis will be on simulations)	CONTENT: Job skills related to specific occupations.
INSTRUCTIONAL RESPONSIBILITY: Cooperative teams of vocational teachers and subject matter teachers	INSTRUCTIONAL RESPONSIBILITY: Vocational Educators	INSTRUCTIONAL RESPONSIBILITY: Vocational educators Industrial trainers Apprenticeship Programs

ENTRY LEVEL JOBS, TRAINING PROGRAMS, AND RETRAINING PROGRAMS

Generalizable Skills refer to the skills which are actively used in work performance, which are transferable across jobs and which are instrumental to success on the job and in the classroom. Typically, Generalizable Skills are associated with the traditional subject matter classes such as mathematics, reading, English, social studies and science and include reasoning, communication (written and oral), interpersonal and attitude skill attainment. These well formed bodies of knowledge are the "basics" of grades 7-12. It is still appropriate and necessary that subject matter teachers continue teaching these subjects, specifically, there is still a need for teachers who teach English, math, science, etc.; however, this is not sufficient.

Researchers (Brammer & Albrego, 1980; Adler, 1982; Daniels & Karmos, 1983; DeBevoise, W., 1982; Givvons, 1984; Goodlad, 1983; Gisi, 1982; Timpane, 1982; Pratzner & Ashley, 1984) have suggested that there exists other skills to be learned which intersect with every subject matter field and vocational education class; these skills have been identified as Transition Skills and Problem Solving Skills. Transition Skills have never been taught directly and Problem Solving Skills have only been taught within specific content areas: math, science, etc.

In order that Problem Solving Skills become more integrated throughout the entire curricula content, it must take on a more generic character; that is, a general modle is needed which could serve two purposes: (1) Problem solving would be taught in all classes, and (2) by using the same model across all subjects a unified approach to problem solving across context and situation would result. As can be seen in Figure 1, it is proposed that all grade 7-12 teachers would be trained to implement this model which would not only include subject specific problems to be solved, but also group and interpersonal problem solving, and transition training.

As students in grade 7-12 go through a myriad of transitions both educationally and developmentally which affect many areas of their lives and which continue across their lifespans, it is suggested that in order to maximize their ability to adapt to these transitions, that they be directly taught skills which would ensure this outcome. Specific training is needed to assist individuals as they pass through transitions. All teachers in grades 7-12 would be trained to teach Transition Skills.

The responsibility of vocational educators in grades 7-12 is central to the implementation of Problem Solving and Transition Skills in that they act as liaisons between the work world and subject matter teachers to strengthen and increase the applicability of problem solving and the reality of transitions that will be confronted during work life. In grades 11 on, vocational educators have the additional responsibility of passing on the skills of getting and holding a job and of assisting students in choosing high tech or other specific skill training. Each of these skills would use the Problem Solving and Transition Skills, emphasizing hands on applications and simulations.

Figure 2 shows a simplified breakdown of reponsibility for instruction.

Figure 2

Grades 7-12	GENERALIZABLE SKILLS	----	Taught by Subject Matter Teachers
Grades 7-12	Problem Solving and Transition Skills	----	Cooperatively taught by vocational education teachers and subject matter teachers. Both would be trained to teach them.
Grades 11-12	First Job Skills High Tech Skills Simulations	----	Vocational education teachers would be trained to teach simulations.

Strategy for Vocational Education

The most important strategy and format for teaching problem solving and transition skills within vocational education is through simulations. Good simulations require utilization of the skills needed to successfully solve problems or manage transitions, and provide an opportunity for students to gain experience and confidence in their ability to deal with issues they may actually confront in their lives and work spaces.

Vocational educators could develop simulations which reflect actual work related problems and transitions such as: problems from quality work groups, worker-supervisor conflicts; transitions caused by lost jobs, being unemployed, being transferred or retrained, by losing friends, being divorced, or being promoted. Other simulations could cover automotive work, air-conditioning, metal work, agriculture, etc. These simulations could involve many subject matter areas (reading, comprehension, understanding graphs, utilizing technical information) and could substantively involve Generalizable Skills. Simulations could provide a rich domain for students to continue to develop and utilize their skills for analyzing and synthesizing information, and then to generalize to conclusions and evaluations. Vocational educators could make school come "alive" for students by simulating problems and transitions that are occurring in their lives, and students could use problem solving and transition skills to manage the simulation. This would enable students to gain confidence in their abilities to manage critical problems and transitions in their personal and work lives.

The World Future Society published a directory of information resources which includes descriptions and references for 45 simulation games (Cornish, 1979. pp. 627-638). Some other resources are:

Simulation Games for the Social Studies Classroom by William A. Nesbitt (1971), Foreign Policy Association, Glenview, IL.

Construction and Use of Written Simulations by Christine McGuire, Lawrence

Solomon, and Philip Bashook (1976), The Psychological Corporation.

Simulation Games in Learning by Sarane Boocock and E.O. Schild (1968), Sage Publications, Beverly Hills, CA.

Examples of simulations using Transition Skills and Problems Solving Skills are given below.

Simulation for Transition Skills

An example of simulations already in existence is the simulation Life-Career (published by Western Publishing Co.). Students make decisions and solve problems for a fictitious person as the person deals with work, marriage, and education. Players plan time and activities relative to school, studying, job, leisure time, and family. The game generates a universe of simulated experiences that students can compare with the real world; that is, they can compare the experiences in the game to what they believe true about their own world. Sarane Boocock (1968) found that Life Career simulation increased students' factual knowledge about careers; established for students that there is a causal relationship between their behavior and the outcome of events; and increased student confidence in their decision making and problem solving abilities.

Simulation for Problem Solving Skills (Taken from a GM Training Manual)

Your company has just obtained a one year contract for delivering six truckloads of hazardous materials a month. All six trucks are enroute, and this is the first time any one of you has driven this busy road. All trucks are identical though they are loaded differently. You will make 11 more deliveries this year.

The second truck is immediately behind the first truck, which is pulling a forklift. Four other trucks are about 15 minutes behind on the same road. The first truck went under a cement underpass with no problem, but the second truck got stuck. Comparing the shipping documents you realize the first truck is carrying 400 containers weighing 50 pounds each. The cargo is on pallets. There is an open truck service station ahead. It has a full equipped wrecker for servicing trucks on the highway.

All the trucks must arrive at the destination 20 miles ahead within one hour or your company will have to pay a penalty. There is an alternate route behind you but it is 10 miles longer with equally heavy traffic. You are members of the crew driving the stuck truck. What will you do?

Transition Model:

For vocational educators to teach problem solving and the handling of transitions through simulations, models for them need to be taught to teachers. A transition model is needed which (a) clarifies transitions, (b) accounts for the developmental issues students experience, and (c) which can be integrated into existing educational programs. Such a model is presented below.

The model is versatile. It is applicable to almost any kind of transition. The model may be used by students contemplating career or college choices, experiencing the loss of a friendship, or dealing with the loss of a parent through death or divorce. Existing programs may be integrated into the model. Some present programs are:

1. Danish and D'Augelli (1980) have developed a comprehensive approach to teaching coping skills for preventing crisis and stress. The program teaches life development skills necessary for dealing with anticipated transitions. It also deals with ways of managing crises or unplanned events and stresses communication and helping skills.
2. Brammer and Abrego (1981) use problem-solving strategies as skills for coping with and responding to transitions.
3. Meichenbaum (1977) presents guidelines for training people to cope with stress. The training model emphasizes cognitive skills and recognizes individual and cultural differences.
4. Fuchs' and Rehm's (1977) program trains people to manage feelings and emotions in dealing with transitions.

Two references (Schlossberg, 1984; Abrego & Brammer, 1979) are useful for high school teachers. Both give excellent guidelines for helping students handle transitions. Educating students to deal with life transitions should be an important part of the high school curriculum. Some guidelines are: 1) students should become aware that life transitions are natural and inevitable and that they already have personal resources for dealing with them. 2) Students should first examine and analyze transitions they are <u>already experiencing</u>. They should become aware of their values, interpersonal skills, competencies, and other personal resources which strengthen their ability to cope with change. 3) Students should perceive instruction as relevant to their present lives so that a meaningful extension can be made to typical anticipated and unanticipated transitions later in life. 4) Students should

become aware of future anticipated transitions such as graduation, leaving home, etc: and future unanticipated transitions such as not being accepted for college, losing a job, the death of a spouse, etc. 5) Throughout the study of transitions, the Model for Handling Transitions should be applied and it should be viewed as a problem solving strategy.

With change and transition as the rule rather than the exception it becomes evident that one of the more pressing concerns before educators today is the empowerment of students to identify, adapt, and manage transitions which occur developmentally, socially, and occupationally in their life courses. Changing times will bring more self-responsibility and more self-help. Maurice Gibbons (1984) noted that ". . .institutional care and support services are diminishing, and people can expect to take more responsibility for themselves throughout their lifetimes. Self-help is replacing institutional help (p. 593)." The management of change and transition must become a part of the learning life of the individual. This model for educating for transition is a beginning.

Problem Solving Model

In addition to a model for teaching about transitions, one is also needed for problem solving. For students to hold jobs, be retrained, and in general to adapt to a constantly accelerating rate of change in their lives, they will need strategies for how to attack and solve problems. Possession of at least one general model for solving problems is one essential strategy. There are many different models, but the one we have developed is given below.

Model for Problem Solving

I. UNDERSTAND THE PROBLEM

- What are the essential data?
- Is there enough information to solve the problem?
- Would a figure or sketch help? Maybe introduce symbols or other variables.
- Separate the problem into manageable parts, if needed. Write down each part.
- Can the problem be restated in a different way to help understand it?

II. BRAINSTORM FOR POSSIBLE SOLUTION STRATEGIES

- Generate a lot of ideas. Don't judge them, just write them down.
- Has a problem like it been solved before?
- Would working a related problem be useful?
- If there were some particular additional information, could the problem be solved? Where could the information be obtained?

III. CHOOSE A TENTATIVE SOLUTION STRATEGY

- Remember, the strategy may not work and the process may have to be started over
- For "people" problems, consequences associated with carrying out tentative strategies must be carefully weighed.
- Also, if people are working out an interpersonal problem, then the tentative strategy will likely be a compromise. No one is likely to get everything they want.

IV. CARRY OUT THE TENTATIVE SOLUTION STRATEGY

- Check each step as the plan is carried out. Check that each step is OK Is each step correct or valid?
- Are there places for errors, mistakes, or faulty reasoning? Where are they?
- Would it be useful to have someone else go over your steps?
- For implementing solutions to "people" problems, decide "Who does What, When." Maybe write it down.

V. LEARN

- Check the result if possible. Is the judgement sound? Does it have a reasonable chance of solving the problem?
- What are the implications or consequences of the solution?
- Could the problem be worked another way? Perhaps look at other people's solutions and hear what they have to say.
- If appropriate, evaluate the effectiveness of the solution.
- Have enough problems like this one been worked to begin to generalize to a plan for solving similar problems?
- Does this solved problem open up new relationships that hadn't been thought of before? Think about it!

At the beginning, we have our students follow the Five Step Model, step by step. Later on they are encouraged to freely use their own creativity and intuition to solve problems since no single model is directly applicable to all problems.

Commercial programs for teaching problem solving exist. The June 1983 issues of the Kappan listed more than 30 programs, video-taped presentations, computer-assisted instruction, instructional programs for teachers, and materials for student use. Other excellent sources are:

- The Edward de Bono School of Thinking, P. O. Box 711, Larchmont, NY 10538
- Institute for the Advancement of Philosophy for Children, Montclair State College, Upper Montclair, NJ 07043
- Problem Solving and Comprehension by Arthur Whimbey and Jack Lochhead, The Franklin Institute Press, Philadelphia, 1979.
- More Life Skills, by Joan Hearn, Advanced Development Division, Employment and Immigration, Ottawa, Canada K1A 0J9, 1982.

° Problem Solving in School Mathematics, 1980 Yearbook, National Council of Teachers of Mathematics, Reston, Virginia.

° Instrumental Enrichment, by Reuven Feurstein, University Park Press, Baltimore, MD., 1980.

° The New MCAT Student Manual (Quantitative Skills) from the Association of American Medical Colleges, Washington, D.C., 1984.

° Medical College Admission Test (Quantitative Skills) by Morris Bramson and Lawrence Solomon, Arco Publishing, Inc., NY, 1982.

° A Complete Preparation for the New MCAT, Vol. II (Quantitative Skills) by Beryl Brain, Drew Love, and Philip Kelleher, Health Professional Education Service, Inc., Bethesda, Maryland, 1981.

Problem solving is a difficult subject to teach. But there are some essential guidelines: (1) students must be given substantive problems to solve and actively pursue their solutions. People learn by doing and their "doing" must have substance. There is no merit in teachers being superb at teaching trivia. (2) Students are to be armed with models and strategies for solving problems. Breaking problems into simple parts, making sketches, reading carefully, etc. are all necessary strategies for good problem solving. (3) Knowledge in specific content areas is necessary for solving problems in that area. One can't solve many problems in mathematics if one doesn't know much math. The best problem solvers have a very broad base of specific and general knowledge. (4) Some problems are more appropriately solved in a group setting and others in an individual setting. The group setting needs to be used more so students can better learn the give and take of cooperation that is now so vital to business and industry. (5) Students need to become more self-reflective of themselves as problem solvers. "What kinds of problems do I have difficulty with?" "What are my strengths, weaknesses?" "Where do I

need to improve?" "What can I learn from that mistake? "How do I learn best--hearing, seeing, touching, imagining?" "Where do I go for help?" Students can always become better problem solvers, and educators can always improve materials and instruction for helping it happen.

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